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INSECT STORIES

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INSECT STORIES

BY

VERNON L. KELLOGG

With Illustrations

BY

MARY WELLMAN, MAUD LANKTREE, AND SEKKO SHIMADA

SECOND EDITION, REVISED

NEW YORK
HENRY HOLT AND COMPANY
1910

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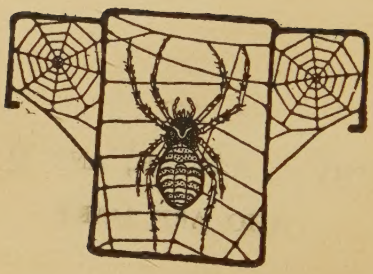
TO

DOROTHY S., ANNA F., AND MARY L.

WHO ARE MARY



PREFATORY NOTE

In these days many strange, true stories about animals are being written and read, but it seems to me that some of our most intimate and interesting animal companions are being overlooked. So I have tried to write about a few of them. These stories are true. I know this, for Mary and I have really seen almost everything I have told; and they seem to us strange. If there have slipped into the stories occasional slight attempts to show some reason for the strange things or to point an unobtrusive moral, it is because the teacher's habit has overcome the story-teller's intention. So the slips may be pardoned.

Of course I recognize that it is taking great chances nowadays with one's repu-

tation for honesty and truth-telling to write or tell stories about animal behavior. Nature writers seem to be held, as a class, not to be above suspicion. But is a truthful man to be kept silent by criticism or abuse, or, on the other hand, is he to surrender, even for cash, to bad examples? I call out, "No!" and beat on the table as I say this until the pens and paper hop, and Mary asks, "No what?" Which reminds me that I must make some exception to my sweeping declaration of the truth of the whole of this little book. I am not responsible for Mary! She is, bless her, a child of dreams, and sometimes her dreams get into her talk. So some of Mary in this book is fancy; but the beasties and their doings are—I say it again—true, quite true.

V. L. K.

Stanford University, California.

LIST OF STORIES

A NARROW-WAISTED MOTHER
RED AND BLACK AGAINST WHITE
THE VENDETTA
THE TRUE STORY OF THE PIT OF MORROWBIE JUKES
ARGIOPE OF THE SILVER SHIELD
THE ORANGE-DWELLERS
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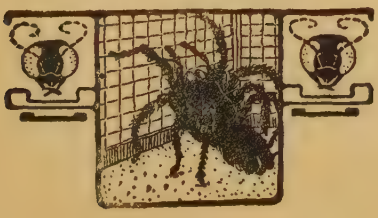
AN HOUR OF LIVING; OR, THE DANCE OF DEATH
IN FUZZY'S GLASS HOUSE
THE ANIMATED HONEY-JARS
HOUSES OF OAK



A NARROW-WAISTED MOTHER

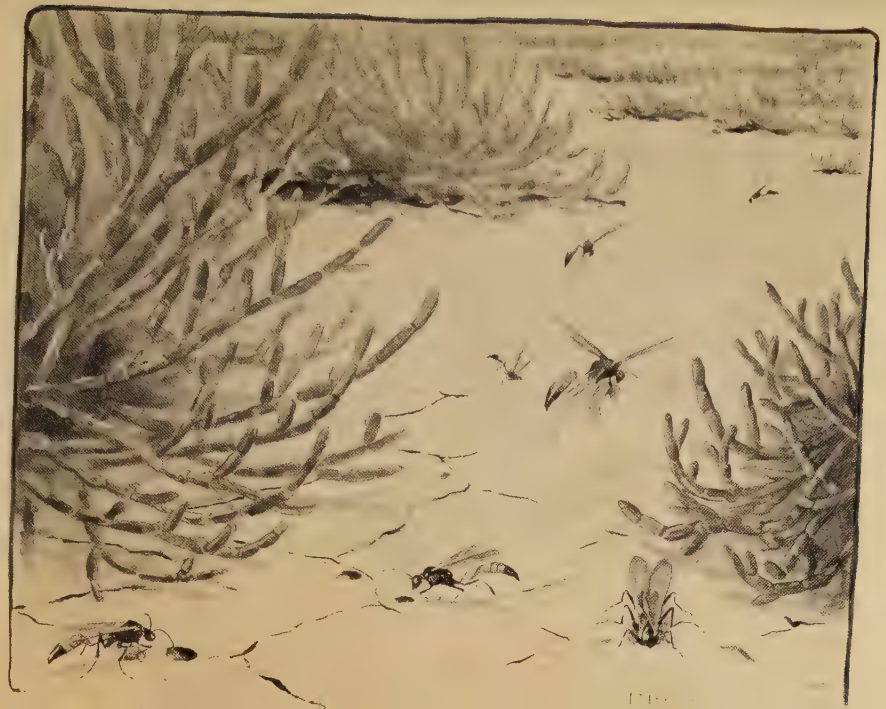
A NARROW-WAISTED MOTHER

I FIRST got acquainted with Mary when she was collecting tarantula holes. This appealed to me strongly. It was so much more interesting than collecting postmarks or even postage-stamps.

It is part of my work, the part which is really my play—to go out and look at things. To do the same, I found out, is Mary's play—which is, of course, her most serious employment. We easily got acquainted when we first met, and made an arrangement to go out and look at things, and collect some of them, together. So after Mary had shown me that collecting tarantula holes is indeed quite simple—although at first thought of it you may not think so—I proposed to her to come along

and help me collect a few wasp holes. They are smaller of course than tarantula holes and do not make quite such a fine showing when you get them home, but they have several real advantages over the spider burrows, only one of which I need tell you now. This one is, that you can watch the wasps make their holes because they do it in the daytime, while you can't watch the tarantula make its hole because it does it at night. So Mary and I went together to the place of the wasps.

I ought to tell you right away that Mary and I live in California. This explains to you partly why we are so happy in our rambles, because for any one whose work or whose play it is to go out and look at things, California is a wonderfully good place to live in. In fact, I know of none better. But I should tell you more of where we live, because California is so many places at once, that is, so many different kinds of places, such as high mountains,



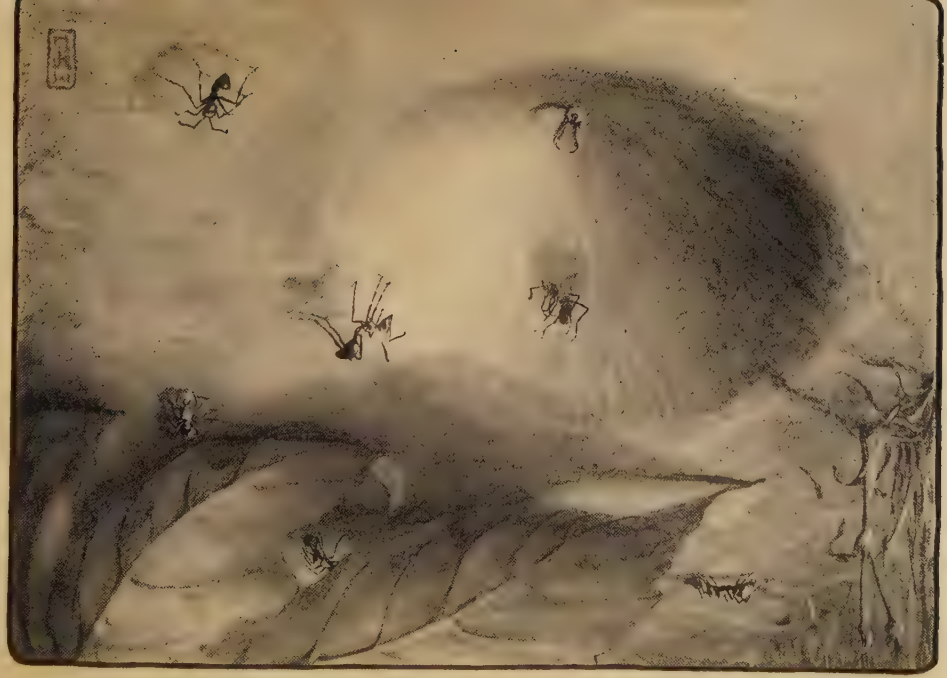
burning deserts, great forests, fertile plains, salt lakes, blue ocean, low soft hills, wide level marshes, fragrant orchards, brilliant flower gardens, hot springs and volcanic cones, deep cañons and rushing rivers,—O, indeed, almost all the kinds of places that the physical geography tells about.

Mary and I live in a beautiful valley between two ranges of mountains and very near the marsh-lined shores of a great ocean bay. Over beyond one range of mountains is the ocean itself stretching blue and ripply all the way to China, while beyond the other range of mountains is a desert with jackrabbits and burrowing owls and cactuses. Not the worst—or best—sort of desert like that far south toward Mexico, but one that gets a little rain, and hence is called a "Land of Great Possibilities" by men who sell pieces of it now and then to people from Maine.

It is easy for us to get from the little town in which we live to several very good

places for looking at things. The foothills and mountain sides with their forests and coverts and swift little brooks; the orchards and flower gardens and grain and grass fields; the wide flat marshes with their salt-grass and pickle-weed, their wide channels and pools, and finally the bay itself; all are near by and all are fine places for observing and collecting things.

When I met Mary first—the time she was collecting tarantula holes—we were on the gentle slopes of the lower foothills of the mountains. The big hairy tarantulas are very numerous there, although one rarely sees them because they mostly stay in their holes in daytime. There are tarantula hawks there too, enormous black and rusty-red wasps with wings stretching three inches from tip to tip. Mary and I saw one of these giant wasps swoop down on a big tarantula just as he came out of his hole one evening after sundown, and that was a battle to remember, and it had a



very strange ending. The tarantula—but I must save that battle for another chapter all to itself. I must try and stick to the wasp holes in this one.

It was a day in September. This month in California is the last one of the long, rainless, sun-filled summer, and everywhere it is very dry and brown. The valley floors and foothill slopes lie thirsty and cracking under the ardent sun, and a thin cover of fine dust lies on all the leaves of the live-oak and eucalyptus trees. Everything out of doors is waiting for the first rain. The birds are still and the frogs all hidden away. The insects buzz about rather heavily and keep pretty well under cover. If one wants to see much lowly life it is necessary to go to the banks of the few persisting streams or lakes or to the shores of bay or ocean. So Mary and I left the dry foothill slopes and their many silk-lined holes with a big black hairy tarantula sitting quietly at the bottom of each, and took

the gently dropping dusty road to the marshes.

I like the salt marshes of California. They are a change and relief, in their soothing monotony and simple plant life, from the lush and variegated flower fields, the dense and hostile chaparral thickets, the dark forests of great trees, and the miles of artificial plantations of orchards and vines. On the marshes you are greater and more important than the plants. In an orchard or a giant-tree forest, you feel second-rate someway. The fruit-trees have men for servants, while to the giant trees with their outlook from a height of three hundred feet and their memories of two thousand years, a man is no more than an ant. But in the marshes you feel that you are much more important a kind of creature than the pickle-weed, and that is almost the only plant that grows there.

There are many curious little bare dry spots in the marsh where we know it.

Flat, smooth, salt-encrusted, clean white spots rather circular in outline, and perhaps twenty feet in diameter. All around is the low thick growth of fat-leaved pickleweed, but for some reason it doesn't invade these pretty little empty rooms. Mary and I like to lie on the clean dry floor of one of these unroofed rooms and look up at the blue sky and out beyond the low side walls of pickle-weed far across the flat marsh stretches, over the shining bay, and on through the quivering blue to the beautiful mountains that bound our views on both sides. On clear afternoons we can see a gleaming white speck on the top of the highest mountain in the eastern range. That is the famous Lick Observatory, where the astronomers are looking always into the sky to read the riddle of the stars and planets and comets. We feel rather small, Mary and I, when we realize that we are only loafing or at best watching insignificant little insects and collecting wasp holes

that lie at our noses' ends, while those men up there are looking at wonders millions of miles away. But we are so interested and contented with our small doings and small wonders that we do not at all envy the astronomers on the mountain top. While they watch the conflagrations of the stars and the mighty sailing of the planets through the blackness of space, we watch the work and play and living of our lowly companions on the sun-flooded marshes. They like the cold glittering sky; we like the warm brown earth.

We had been lying quietly on the white salt sand in one of the unroofed marsh rooms for some time this September day before we saw the first wasp begin to work. She was standing on her head, apparently, and biting most energetically with her jaws, cutting a little circle in the salt crust. When she got the circle all cut, she tugged and buzzed until she dug up, unbroken, the little circular piece (perhaps one-third

of an inch across) of crust. She dragged this about three inches away. Then she returned to the spot thus cleaned and dug out with her sharp jaws a bit or pellet of soil. Holding this in her mouth, she flew away about a foot and dropped it. Then came back. Then dug out another pellet of soil and carried and dropped it a foot or so away. Then back again and so on until it was plain that she was digging out a little cylindrical vertical hole or burrow. As the hole got deeper, the wasp had to crawl down into it, first with head and fore legs, then with head and half her body; finally her whole body, long legs, wings and all, was hidden as she dug deeper and deeper. She had to come out of the hole of course to carry away each bit of dug up soil. She always backed upward out of the burrow, and all the while she was digging she kept up a low humming sound. It was this humming sound that attracted our attention to other narrow-waisted

wasps like the first one. By moving about cautiously and listening and looking carefully, we found more than a dozen others digging holes, each one going about the work just like every other one.

When our first wasp had made its hole deep enough—this took a pretty long time; we found out later that it was about three inches deep—she brought back the first little circular piece of salt crust and carefully put it over the top of the burrow, thus covering it up entirely and making it look as if no hole were there. Then she flew away, out of the little bare room and off into the pickle-weed somewhere. We waited several minutes but she didn't come back, so we turned our eyes to another wasp near by which had its hole only just begun. It was interesting to see how closely like the first wasp this second one worked. Prying and pulling with the jaws, the same fluttering of the wings and humming, the same backing out of the hole and

the swift little flight for a foot or two feet away from the hole to drop the pellet of soil.

I tried to point out to Mary that this was the way animals do which work by instinct and not by reason. That all the animals of the same kind do things in the same way, and that they do them without any teaching or imitating or reasoning out. They are born with the knowledge and skill and the impulse to do the things in the particular way they do. But Mary found this very tiresome and let her eyes rove, and it is well she did or we might not have made our great discovery: a really thrilling discovery it was for us, too.

The first wasp had come back! But not empty handed, or rather not empty mouthed, for in her pointed jaws she held a limp measuring-worm about an inch and a quarter long. A measuring-worm or looper is the caterpillar of a certain kind of moth, and it loops or measures when it

walks because it has no feet on the middle of the under side of the body as other caterpillars have, and so has to draw its tail pretty nearly up its head to take a step forward. This naturally makes its body rise up in a fold or loop. "See," cried Mary, "the wasp is going to put the measuring-worm into the hole."

That is exactly what happened. How the wasp could tell where the hole was, was surprising, for it had so carefully put the bit of salt crust in place that you couldn't tell the top of the hole from the rest of the crust-covered ground. But our wasp came straight to the right place. Perhaps as a carrier-pigeon comes to its loft from a hundred miles away, or a cat carried away in a bag to a strange place finds its way quickly back home.

Some of the other wasps that we watched later weren't so sure of their holes, though, and other people who have watched digger-wasps in other places have found them

showing varying degrees of uncertainty about locating their nests. Mr. and Mrs. Peckham, who have studied the behavior of the various kinds of digger-wasps more than anybody else in this country, have concluded that the wasps "are guided in their movements by their memory of localities. They go from place to place quite readily because they are familiar with the details of the landscape in the district they inhabit. Fair eyesight and a moderately good memory on their part are all that need be assumed in this simple explanation of the problem."

But quite different from this conclusion is that of Fabre, the wonderful French observer of wasps, who experimented on them in regard to this matter of finding and knowing their holes, by carrying them away shut up in a dark box to the center of a village three kilometers from the nesting ground, and releasing them after being kept all night in the dark boxes. These

wasps when released in the busy town, certainly a place never visited by them before, immediately mounted vertically to above the roofs and then instantly and energetically flew south, which was the direction of their holes. Nine separate wasps released one at a time did this without a moment's hesitation, and the next day Fabre found them all at work again at their hole-digging. He knew them by two spots of white paint he had put on each one.

"Are the wasps guided by memory when placed by man beyond their bearings and carried to great distances into regions with which they are unacquainted and in unknown directions?" asks Fabre. "By memory so quick that when, having reached a certain height at which they can in some sort take their bearings, they launch themselves with all their power of wing towards that part of the horizon where their nests are? Is it memory which traces their aerial way across regions seen for the first

time? Evidently not," emphatically declares Fabre. So there you are. Where doctors (of science) fall out it is not for you or me to decide.

But Mary was growing excited. "See, she has put the worm down and is prying up the top of the hole. She has got it off. She is—"

"Ss-h," say I, for wasps can hear. Or, wait; that's quite dogmatic. Wasps fly away when you talk too loud. That's better. That's not judging wasp doing by what we can do. That is just telling an observed fact.

Mary "ssh"-ed, but she pointed a plump little finger; a finger trembling with excitement. The wasp had gone down into the uncovered hole with the worm. Then she backed out, found the lid, covered up the hole and flew away into the pickle-weed again!

In twenty minutes she came back, *with another limp measuring-worm*, straight to

the covered hole; worm dropped on the ground; lid taken off; worm dragged in; wasp backed out; lid carefully replaced; flight to the distant jungle of pickle-weed again!

O, this was exciting. Mary fairly exploded into exclamations and questions after the wasp was well away. What are the worms for? Are they dead? The second one seemed to wriggle feebly a little on the ground by the nest while the wasp was getting off the lid. Will she bring more? Will she fill the hole full of worms? Now I knew the answers to some of these questions, for I had been in this happy place before, but I wanted Mary to find out, to discover—exquisite and prideful pleasure—for herself. So I remained dumb.

Three more times the wasp brought worms. Three more times went through all the performance. But the last time she didn't come up for a long time; that

is, for several minutes, and when she did come, instead of putting the salt crust on the hole, she got a little pellet of soil and dropped it in; and then another, and many others. Sometimes she scraped them in with her front feet, but there weren't many bits of soil close enough for that, for she had carried them all a foot or so away as she brought them out of the hole. She worked very industriously: jumping and running about, making little buzzing leaps and flights, until she had quite filled up the hole with the five dead worms in the bottom.

Then she did the most wonderful thing. With her fore feet she pawed and raked the surface until it was quite smooth, and with her jaws and horny head she pressed down and tamped the fine bits of soil until they were a little below the surface of the salt crust around the hole, and then she brought again the little circular lid or top of salt crust and carefully put it in the little de-

pression on the top of the filled-in burrow, so that it fitted perfectly with the hard uncut salt crust around the hole's edge!

This is true. Does it seem wonderful to you? Why? Because we think that other animals cannot do what would be a very simple thing indeed for us? Our wasp was evidently concealing the whereabouts of her worm-stored burrow. I don't say that she *wanted* to conceal it; or *decided* to conceal it; or even *intended* to conceal it. She was simply, I say, concealing it. That seems quite certain, doesn't it? Well, this action of cutting out and replacing the bit of salt crust over the burrow was about the simplest and most effective way of concealing the hole that could be reasoned out, if we ourselves were to undertake it. The wasp, and all the other wasps of the same kind in our marshes, concealed their holes in the way that our reason would suggest to us as the best way. But I do not say anything about the wasp's mental

processes toward getting at this behavior. One thing is pretty sure. Among a score or hundred of us doing this work, there would be pretty sure to be some to do it in a different sort of way from the others. The wasps of the same kind all do it alike. Perhaps that is the chief difference between reason and instinct.

But if our digger-wasp—whose name is Ammophila, the sand-lover—made Mary's and my eyes bulge out by her cleverness, what shall we think of that other Ammophila that Dr. Williston watched on the plains of Kansas, or that other one still which the Peckhams studied in Wisconsin? These other Ammophilas, instead of using their hard heads to tamp down the soil in the hole, hunted about until they found a suitable little stone which, held tightly in the jaws, was used as a tool to pack and smooth the dirt! And the Kansas wasp did another odd thing. Instead of making its hole of the same caliber or width all the

way down, the upper half-inch or so was made of greater diameter than the rest of the burrow so that a little circular shelf ran around the inside of the hole half an inch below the top. Now when the clever Kansas wasp closed the burrow each time it went away to hunt for measuring-worms, it did it in a curious way. I quote the exact words of Professor Williston, the observer: "When the excavation had been carried to the required depth"—this is our professional way of saying, when the hole had been dug deep enough—"the wasp, after surveying the premises, flying away, soon returned with a large pebble in its mandibles, which it carefully deposited within the opening; then, standing over the entrance upon her four posterior feet, she rapidly and most amusingly scraped the dust, 'hand over hand' back beneath her till she had filled the hole above the stone to the top. [The stone of course was resting on the little circular shelf half an

inch down in the hole.] . . . When she had heaped up the dirt to her satisfaction, she again flew away and immediately returned with a smaller pebble, perhaps an eighth of an inch in diameter, and then standing more nearly erect, with the front feet folded beneath her, she pressed down the dust all over and about the opening, smoothing off the surface and accompanying the action with a peculiar rasping sound."

Is this not a creature of wits, this Kansas wasp? And an undaunted worker? For each time she went away to get a nice fat looper, she covered up her hole in this elaborate way, and each time she came back, she had to remove the half-inch of tamped-down soil and the little covering stone resting on the shelf in the hole.

The Peckhams, too, saw an Ammophila in Wisconsin use a pebble as a tool, and what is especially interesting and impor-

tant, this wasp was only a single individual of several others watched by the observers, all these wasps being of one kind, that is, belonging to the same species. The tool-user thus revealed an individuality that made its actions seem to be dictated by something else than rigid instinct; certainly so if instinct is to be defined as untaught and unreasoned behavior common to all the individuals of a kind. In fact the Peckhams (most persistent, practised and intelligent observers) insist that "in all the processes of Ammophila the character of the work differs with the individual."

But where is Mary in all this digression of mine? Never fear for Mary. While I was mumbling about instinct and reason and automatism and individual idiosyncrasy, Mary was crawling slowly and cautiously about over the salt-crust floor of our room, counting the wasp holes in course of making, and she was making a second

discovery. The measuring-worms, limp and lifeless as they appeared, were really not dead! She had seen at least two, left lying on the ground by the hole while the wasp prized off the cover, give feeble wriggles, and one that she poked with a pin squirmed rather energetically. That is, it did if she poked it at one end, but not if she poked it in the middle, which is such a great discovery that it really gets to be science!

Now as one is entitled to take violent measures for the sake of science, Mary and I decided after considerable serious discussion to "collect" the hole which our wasp had finished and apparently left for good. So we dug it up, and on the spot we examined it and all of its insides. And we found it quite true that the loopers were not dead, but they were *paralyzed!* When we poked a head or tail, each worm could squirm just a little, but if we touched them in the middle, they didn't know it, and on one of

them, the top one, we found a little shining white speck.

Mary's excitement became merged into an intense thoughtfulness. Then she cried aloud with eyes shining: "My, its the egg! the egg of the wasp! and the worms are for food for the young wasp when it hatches!"

Ah, Mary, you have wits! Have you ever heard any one tell about this? Did you really guess it, or not guess it, but actually reason it out for yourself? Mary, I have great hopes of you.

For it is quite true what Mary says. The little white seed-like thing glued on to the last looper's body is the egg of the wasp, and the stung and paralyzed but not killed measuring-worms are the food stored up by this extremely clever narrow-waisted mother for the wingless, footless, blind, almost helpless wasp grub, when it shall hatch from the egg. Down in the darkness of the cell, there will be a horrible tragedy. For days and weeks together the

wasp grub will nibble away on the helpless loopers until all five are eaten alive! Then the grub will change to a winged wasp with strong sharp jaws with which she will dig her way up and out of the noisome prison and into the free air and sunlight of the marsh room. And she will then dig holes of her own, find and sting and store loopers, lay an egg on one, and close up the hole just as her mother did. Or at least all this would happen if we hadn't collected the hole. But it will happen in the other holes.

But why should the loopers be only paralyzed instead of killed? Isn't it plain that if killed they would only be decaying carrion by the time the wasp grub was ready to eat them, and young wasps must have fresh meat, not dead and decayed flesh. And if the loopers were simply put in alive, not paralyzed, wouldn't their violent squirming in the hole surely crush the delicate egg or the more delicate newly hatched wasp grub? Or wouldn't they

simply dig their way with their heavy jaws out of the hole and away? Or, indeed, could the slender-bodied mother wasp carry and handle successfully a strong squirming looper over an inch long? The reason for the paralyzing of the worms is plain then. But how is this extraordinary condition brought about? And the answer to this, which Mary and I didn't discover for ourselves, but had to find out from the accounts of the men who did, like Fabre and others, reveals the most extraordinary thing that our wasps do. Most people think the wasps that live in communities or large families in big paper nests (the yellow-jackets and hornets) are the most interesting and most intelligent or clever of the wasps. But Mary and I do not think so. The solitary wasps do the most wonderful things, and of all they do, the paralyzing of the insects they store up as food for their young is the hardest to explain on any basis except that of wasp

reasoning. But of course we don't have to explain it, which is fortunate for the high record of truth we are trying to establish in this book.

Fabre, the patient Frenchman, waited for years and years for a chance to see just how the Ammophila paralyzes her victims, and at last he saw and understood it. To understand the matter from Fabre's account of it, we must remember that the measuring-worm's body is made up of a series of rings or body segments, in each of which (except the very last) is a little nerve center or brain situated just under the skin on the under side of the body. And all this row of brains is connected by a slender nerve cord running along the middle line of the under side of the long body. Now Fabre saw that the wasp darted its sting into each looper, "once for all at the fifth or sixth segment of the victim." And when he pricked the stung worms with a needle in various parts of the body, he

found, just as Mary did, that the needle could entirely pierce the middle of the body (which is where the fifth and sixth segments are), without causing any movement of the worm. "But prick even slightly a segment in front or behind and the caterpillar struggles with a violence proportioned to the distance from the poisoned segment."

Now what is the reason, asks Fabre, for the wasp's selecting this particular spot for stinging the worm, and he answers his own question as follows:

"The loopers have the following organization, counting the head as the first segment: Three pairs of true feet on rings two, three, and four; four pairs of membranous feet on rings seven, eight, nine, and ten, and a last similar pair set on the thirteenth and final ring; in all eight pairs of feet, the first seven making two marked groups—one of three, the other of four pairs. These two groups are divided by two segments without feet, which are the fifth and sixth.

"Now, to deprive the caterpillar of means of escape, and to render it motionless, will the Hymenopteron [that's the wasp] dart its sting into each of the eight rings provided with feet? Especially will it do so when the prey is small and weak? Certainly not: a single stab will suffice if given in a central spot, whence the torpor produced by the venomous droplet can spread gradually with as little delay as possible into the midst of those segments which bear feet. There can be no doubt which to choose for this single inoculation; it must be the fifth or sixth, which separate the two groups of locomotive rings. The point indicated by rational deduction is also the one adopted by instinct. Finally, let us add that the egg of the Ammophila is invariably laid on the paralyzed ring. There, and there alone, can the young larva bite without inducing dangerous contortions; where a needle prick has no effect, the bite of a grub will have none either,

and the prey will remain immovable until the nursling has gained strength and can bite farther on without danger."

But some Ammophilas catch much larger caterpillars than the inch-long, slender, little loopers. Fabre found a wasp dragging to its nest a caterpillar weighing fifteen times the weight of the wasp. Does one stab suffice for such a giant caterpillar? Here is what Fabre saw: An Ammophila was noticed scratching in the ground around the crown of a plant. She was "pulling up little grass roots, and poking her head under the tiny clods which she raised up, and running hurriedly, now here, now there, round the thyme, visiting every crack which gave access under it; yet she was not digging a burrow, but hunting something hidden underground, as was shown by manœuvres like those of a dog trying to get a rabbit out of its hole. And presently, disturbed by what was going on overhead and closely tracked by the Ammophila, a big gray

worm made up his mind to quit his abode and come up to daylight. It is all over with him; the hunter is instantly on the spot, gripping the nape of his neck and holding on in spite of his contortions. Settled on the monster's back, the Ammophila bends her abdomen, and, methodically, deliberately—like a surgeon thoroughly familiar with the anatomy of his subject—plunges a lancet into the ventral surface of every segment, from the first to the last. Not one ring is omitted; with or without feet each is stabbed in due order from the front to the back."

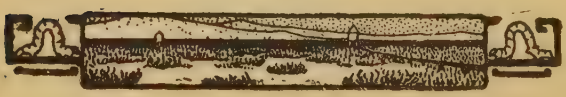
This is what the patient, careful observer saw, with all the "leisure and ease required for an irreproachable observation." "The wasp acts," says Fabre, "with a precision of which science might be jealous; it knows what man but rarely knows; it is acquainted with the complex nervous system of its victim, and keeps repeated stabs for those with numerous ganglia. I said 'It knows;

is acquainted'; what I ought to say is, 'It acts as if it did.' What it does is suggested to it; the creature obeys, impelled by instinct, without reasoning on what it does. But whence comes this sublime instinct? Can theories of atavism, of selection, of the struggle for life, interpret it reasonably?"

When I had finished reading this to Mary she looked up and said softly: "Of course I don't understand all this that he says about 'avatism and selection' and so on, but I think the wasp knows. Don't you?"

"Mary," I reply promptly, "the word is 'atavism,' not 'avatism,' please remember!"

"I hope I can," said Mary.



RED AND BLACK AGAINST WHITE

RED AND BLACK AGAINST WHITE

THE meadow lark on the fence post behind my house is unusually voluble this uncertain morning; maybe he is getting his day's singing off before the sun shall hide, discomfited, behind the unrolling cloud furls. A solemn grackle, with yellow eyes and bronzed neck, stalks with cocking head in the wet green of the well-groomed front lawn; a whisking bevy of goldfinches, which chat to each other in high-pitched hurried phrases, disposes itself with much concern in the bare tree across the road, and swinging along overhead, a woodpecker cries its harsh greetings. But the life here on the street is tame and usual compared to that busy living and to those eventful happenings taking place in a re-

moter corner of the garden. There where the warm dust is figured with the dainty tracks of the quail hosts and the flower-flies hum their contentedest note; there in that half-artificial, half-wild covert of odorous vegetation, a life in miniature, with the excitement and stresses, the failures and successes and the inevitable comedies and tragedies of any world of life is going on, with the history of it all unrecorded.

Mary has just come to call on me, bringing an unkempt bouquet of Scotch broom from the garden. On these branches of broom are many conspicuous white spots. They are not flowers, for it is not broom flower time, and the flowers are yellow when their time does come. But these white spots, soft little cottony masses, like little pillows or cushions, and with regular tiny flutings along the top, have puzzled Mary, and she has come to ask me about them, for I am supposed to know all things. Well, luckily, I do happen to know about these,

but I suggest that we go into the garden together and see if we can find out. The truth is, I am glad of an excuse to get away from this tiresome German book about *Entwicklungslehre*. And then, too, I want to look at things and talk with Mary.

Mary has such a fascinatingly serious way of doing things that aren't serious at all. She has got the curious notion lately that many little people live among the grasses, the grass people she calls them, and that that is the reason there are so many very little white flowers coming up in my lawn. My own notion had been that some rascally seedsman had sold me unclean grass seed, but Mary's notion that the grass people are planting and raising these little flowers for their own special delectation is, of course, a much wiser one. So when we walk on the lawn, we go very slowly, and I have to poke constantly among the grasses with my stick as we move along so that the little people may know we are coming and

have time to scurry away from under our great boots.

When we got out to the row of brooms, we found many of the soft white cushions on all the bushes. But some of them were torn and dishevelled. And in these torn masses many tiny round particles could be seen. These little black specks are simply eggs, insect eggs, as I told Mary, and soon she had discovered among them some slightly larger but still very small red spots which were waving tiny black feet and feelers about. They were of course the baby insects just hatching from the eggs.

"Does the mother lay the eggs in these little white cushions and then go away and leave them?" asks Mary.

"No, she stays right by them," I answer.

"But where is she then? I can't— Yes I can too," cries Mary in great triumph. "Here she is at one end of the egg cushion. She is a part of it."

"Well, no, not exactly," I have to say.

"It is part of *her*, or rather she spins the cushion, which is really a sac or soft box of white wax, in which to lay her eggs. Something the way the spiders do, you know. Only their egg box is made of silk and usually fastened to a fence rail or on the bark of a tree and left there. But some of the spiders, the large, swiftly running, black kinds that live under stones, carry the silken ball with the eggs inside about with them, fastened to the end of the body. Well, this cottony cushion scale insect—that's its right name—keeps its waxen sac of eggs fastened to it, but as the egg sac is much larger than the insect itself, it can't run about any more, but has to stay for all the rest of the time until it dies in the spot where it makes the sac. However, as it gets all the food it wants by sticking its slender little beak into the broom or other plant it is on and sucking up the fresh sap, it gets on very well."

"But what makes some of the egg cush-

ions—how pretty they are, too!—so torn and pulled open," asks Mary, who has listened to my long speech very nicely. She often gets impatient when I lecture for too many minutes together.

"That is for you to find out," I say. "There is a dreadful thing going on here if you can only see it. But a rather good thing too. Good for the broom bushes anyway, and as they are *my* broom bushes and I like their flowers, good for me."

Just then a very stubby, round-backed, quick little red beetle with black spots walked off a broom stem on to Mary's hand. She didn't scream, of course, nor even jerk her hand away. She may learn when she is older to be frightened when pretty, harmless, little lady-bird beetles walk on her. But now she likes all sorts of small animals, and is not afraid at all.

Mary is not at all slow to understand things, and when this hard-bodied little beetle, with a body like half a red-and-black

pill, walked off the broom on to her hand, she guessed that he might have something to do with the torn-up egg cushions. So it didn't take her long to find another little beast like him actually nosing about in an egg sac and voraciously snapping up all the unfortunate tiny, red, black-legged baby scale insects. He ate the eggs, too, and seemed to take some bites at the mother insect herself, and then Mary found more of the lady-bird beetles, and still more. They were on all the broom bushes where the white cushions were. And so one of the dreadful tragedies going on in my garden was soon quite plain to Mary, and she was very sorry for the helpless white insects.

"Where did the red beetles come from?" she asked pretty soon.

"From Australia," I answered. "Or rather their great-great-grandparents did. These particular beetles were probably born right here in the garden, because a colony

of them live here. But they couldn't if there were not some cottony cushion scale insects here too. For these particular lady-bird beetles can't live on any other food—at least they don't—except this particular kind of scale insect and its eggs, which is surely a curious thing, isn't it?"

But Mary is so used to finding that the insects have extremely unusual and curious habits—that is, habits different from ours—that she doesn't get excited any more when I tell her about them. She does though when she finds them out for herself, which makes me wonder if I haven't wasted a good deal of time in my life giving lectures to students about things instead of always making them find out for themselves. And maybe I am wasting some more time now while I am writing!

"How did they come from Australia?" asks Mary. For she knows that Australia is several thousand miles away across the ocean from California, and lady-bird beetles

do not swim. At least not from Australia to America. So I have to give Mary another informing lecture, and this is it:

"Years and years ago, there lived in some fragrant-leaved orange-trees in Australia some white cottony cushion insects whose life was untroubled by other cares than those of eating and of looking after the children. As each insect was fastened for life on the leaf or twig that supplied it with all the food it needed, which was simply an occasional drink of sap, and as the white insects always died before their children were born, neither of these cares was very harassing. On thousands of other similar fragrant-leaved orange-trees in Australia lived millions of other similar white insects. And for a long time this race of white insects enjoyed life. Those were happy days But on a time there came into one of the trees a few small red beetles, who eagerly and persistently set about the awful business of eating the defenceless white insects.

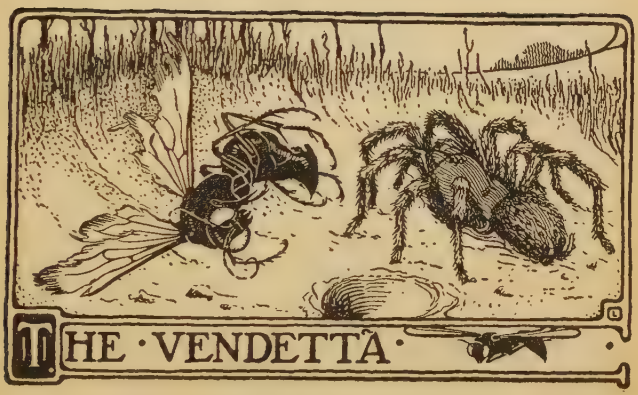
From this tree the red beetles, or the children of them, went to other trees where white insects lived, and with unrelenting rapacity and uncloyed appetite ate all the white insects they could find. And so in other trees; and finally, with years, the red beetles had invaded all of the thousands of fragrant-leaved orange-trees in Australia, and had eaten nearly all of the millions of white insects.

"One day a very small orange-tree was taken out of the ground in Australia and sent with many others across the ocean to California. On this small tree there were a few of the white insects. The little tree was planted again in California and soon put out many fresh fragrant leaves. The white insects were astonished and rejoiced that day after day went by without the appearance of any red beetles. The white insects increased in numbers; there were thousands of fragrant-leaved orange-trees in California, and in a few years there were

millions of white insects in them. One morning a man stood among the trees and said, 'Confound these bugs; they'll ruin me; what shall I do?' and a man who knew said, 'Get some red beetles from Australia.' So this orange-grower, with some others, paid a man to go to Australia and collect some live red beetles. The collector went across the ocean, three weeks' steady steaming, and sent back a few of the voracious little beetles in a pill box. They were put into a tree in a California orange-orchard in which there were many cottony cushion scale insects. The red insects promptly began eating the white ones; and their children and grandchildren and great-grandchildren have kept up this eating ever since. And so the orange-growers never tire of telling how the red beetles (whose name is Vedalia) were brought from Australia to save them from ruin by the white insects (whose name is Icerya)."

Now there are not many cottony cush-

ion scales left in Califorina. A very promising colony of them seems to have sprung up in my Scotch broom bushes. But the red beetles have found their way there already, as Mary and I discovered to-day, and so we think that by the time the broom flowers come, there will be few white insects left in the bushes.


THE · VENDETTA ·

THE VENDETTA

THIS is the story of a fight. In the first story of this book, I said that Mary and I had seen a remarkable fight one evening at sundown on the slopes of the bare brown foothills west of the campus. It was not a battle of armies—we have seen that, too, in the little world we watch,—but a combat of gladiators, a struggle between two champions born and bred for fighting, and particularly for fighting each other. One champion was Eurypelma, the great, black, hairy, eight-legged, strong-fanged tarantula of California, and the other was Pepsis, a mighty wasp in dull-blue mail, with rusty-red wings and a poisonous javelin of a sting that might well frighten either you or me. Do you have any wasp in your

neighborhood of the ferocity and strength and size of Pepsis? If not, you can hardly realize what a terrible creature she is. With her strong hard-cased body an inch and a half long, borne on powerful wings that expand fully three inches, and her long and strong needle-pointed sting that darts in and out like a flash and is always full of virulent poison, Pepsis is certainly queen of all the wasp amazons. But if that is so, no less is Eurypelma greatest, most dreadful, and fiercest, and hence king, of all the spiders in this country. In South America and perhaps elsewhere in the tropics, live the fierce bird-spiders with thick legs extending three inches or more on each side of their ugly hairy bodies. Eurypelma, the California tarantula, is not quite so large as that, nor does he stalk, pounce on and kill little birds as his South American cousin is said. to do, but he is nevertheless a tremendous and fear-inspiring creature among the small beasties of field and meadow.

But not all Eurypelmas are so ferocious; or at least are not ferocious all the time. There are individual differences among them. Perhaps it is a matter of age or health. Anyway, I had a pet tarantula which I kept in an open jar in my room for several weeks, and I could handle him with impunity. He would sit gently on my hand, or walk deliberately up my arm, with his eight, fixed, shining, little reddish eyes staring hard at me, and his long seven-jointed hairy legs swinging gently and rhythmically along, without a sign of hesitation or excitement. His hair was almost gray and perhaps this hoariness and general sedateness betokened a ripe old age. But his great fangs were unblunted, his supply of poison undiminished, and his skill in striking and killing his prey still perfect, as often proved at his feeding times. He is quite the largest Eurypelma I have ever seen. He measures —for I still have his body, carefully stuffed,

and fastened on a block with legs all spread out—five inches from tip to tip of opposite legs.

At the same time that I had this hoary old tarantula, I had another smaller, coal-black fellow who went into a perfect ecstasy of anger and ferocity every time any one came near him. He would stand on his hind legs and paw wildly with fore legs and palpi, and lunge forward fiercely at my inquisitive pencil. I found him originally in the middle of an entry into a classroom, holding at bay an entire excited class of art students armed with mahl-sticks and paint-brushes. The students were mostly women, and I was hailed as deliverer and greatest *dompteur* of beasts when I scooped Eurypelma up in a bottle and walked off with him.

But this is not telling of the sundown fight that Mary and I saw together. We had been over to the sand-cut by the golf links, after mining-bees, and were coming

home with a fine lot of their holes and some of the bees themselves, when Mary suddenly called to me to "see the nice tarantula."

Perhaps nice isn't the best word for him, but he certainly was an unusually imposing and fluffy-haired and fierce-looking brute of a tarantula. He had rather an owly way about him, as if he had come out from his hole too early and was dazed and half-blinded by the light. Tarantulas are night prowlers; they do all their hunting after dark, dig their holes and, indeed, carry on all the various businesses of their life in the night-time. The occasional one found walking about in daytime has made a mistake, someway, and he blunders around quite like an owl in the sunshine.

All of a sudden, while Mary and I were smiling at this too early bird of a tarantula, he went up on his hind legs in fighting attitude, and at the same instant down darted a great tarantula hawk, that is, a

Pepsis wasp. Her armored body glinted cool and metallic in the red sunset light, and her great wings had a suggestive shining of dull fire about them. She checked her swoop just before reaching Eurypelma, and made a quick dart over him, and then a quick turn back, intending to catch the tarantula in the rear. But lethargic and owly as Eurypelma had been a moment before, he was now all alertness and agility. He had to be. He was defending his life. One full fair stab of the poisoned javelin, sheathed but ready at the tip of the flexible, blue-black body hovering over him, and it would be over with Eurypelma. And he knew it. Or perhaps he didn't. But he acted as if he did. He was going to do his best not to be stabbed; that was sure. And Pepsis was going to do her best to stab; that also was quickly certain.

At the same time Pepsis knew—or anyway acted as if she did—that to be struck by one or both of those terrible vertical,

poison-filled fangs was sure death. It would be like a blow from a battle-axe, with the added horror of mortal poison poured into the wound.

So Eurypelma about-faced like a flash, and Pepsis was foiled in her strategy. She flew up and a yard away, then returned to the attack. She flew about in swift circles over his head, preparatory to darting in again. But Eurypelma was ready. As she swooped viciously down, he lunged up and forward with a half-leap, half-forward fall, and came within an ace of striking the trailing blue-black abdomen with his reaching fangs. Indeed it seemed to Mary and me as if they really grazed the metallic body. But evidently they had not pierced the smooth armor. Nor had Pepsis in that breathless moment of close quarters been able to plant her lance. She whirled up, high this time but immediately back, although a little more wary evidently, for she checked her downward plunge three

or four inches from the dancing champion on the ground. And so for wild minute after minute it went on; Eurypelma always up and tip-toeing on those strong hind legs, with open, armed mouth always toward the point of attack, and Pepsis ever darting down, up, over, across, and in and out in dizzy dashes, but never quite closing.

Were Mary and I excited? Not a word could we utter; only now and then a swift intake of breath; a stifled "O" or "Ah" or "See." And then of a sudden came the end. Pepsis saw her chance. A lightning swoop carried her right on to the hairy champion. The quivering lance shot home. The poison coursed into the great soft body. But at the same moment the terrible fangs struck fair on the blue armor and crashed through it. Two awful wounds, and the wings of dull fire beat violently only to strike up a little cloud of dust and whirl the mangled body around and around.

Fortunately Death was merciful, and the brave amazon made a quick end.

But what of Eurypelma, the killer? Was it well with him? The sting-made wound itself was of little moment; it closed as soon as the lancet withdrew. But not before the delicate poison sac at its base inside the wasp-body had contracted and squirted down the slender hollow of the sting a drop of liquid fire. And so it was not well with Eurypelma in his insides. Victor he seemed to be, but if he could think, he must have had grave doubts about the joys of victory.

For a curious drowsiness was coming over him. Perhaps, disquieting thought, it was the approaching stupor of the poison's working. His strong long legs became limp, they would not work regularly, they could not hold his heavy hairy body up from the ground. He would get into his hole and rest. But it was too late. And after a few uneven steps, victor Eury-

pelma settled heavily down beside his amazon victim, inert and forevermore beyond fighting. He was paralyzed.

And so Mary and I brought him home in our collecting box, together with the torn body of Pepsis with her wings of slow fire dulled by the dust of her last struggles. And though it is a whole month now since Eurypelma received his stab from the poisoned javelin of Pepsis, he has not recovered; nor will he ever. When you touch him, he draws up slowly one leg after another, or moves a palpus feebly. But it is living death; a hopeless paralytic is the king.

Dear reader, you are of course as bright as Mary, and so you have noticed, as she did right away, the close parallel between what happened to Eurypelma and what happened to the measuring-worms brought by Ammophila to her nest burrow as described in the first story in this book. And so, like Mary, you realize that the vendetta

or life feud between the tarantula family and the family of Pepsis, the tarantula hawk, is based on reasons of domestic economy rather than on those of sentiment, which determine vendettas in Corsica and feuds in Kentucky.

To be quite plain, Pepsis fights Eurypelma to get his huge, juicy body for food for her young; and Eurypelma fights Pepsis to keep from becoming paralyzed provender. If Pepsis had escaped unhurt in the combat at which Mary and I "assisted," as the French say, as enthralled spectators, we should have seen her drag by mighty effort the limp, paralyzed, spider giant to her nest hole not far distant—a great hole twelve inches deep and with a side chamber at the bottom. There she would have thrust him down the throat of the burrow, and then crawled in and laid an egg on the helpless beast, from which in time would have hatched the carnivorous wasp grub. Pepsis has many close allies among the

wasps, all black or steely blue with smoky or dull-bronze wings, and they all use spiders, stung and paralyzed, to store their nest holes with.

"Do the little black and blue wasps hunt the little spiders and the larger ones the big spiders?" asks Mary.

"Exactly," I respond, "and the giant wasp of them all, Pepsis, the queen of the wasp amazons, hunts only the biggest spider of them all, Eurypelma, the tarantula king, and we have seen her do it."

"Well," says Mary, "even if she wants him for her children to eat, it's a real bendetta, isn't it?"

"Indeed it is," I answer, "it's more real, and fiercer, and more relentless, and more persistent than any human vendetta that ever was. For every Pepsis mother in the world is always hunting for Eurypelmas to fight. And not *all* Corsicans have a vendetta on hand, nor all Kentuckians a feud."

THE·TRVE·STORY·OF·THE·PIT·OF·MORROWBIE·JVKES

THE TRUE STORY OF THE PIT OF MORROWBIE JUKES

"It seemed that some one was calling to me in a whisper—'Sahib! Sahib! Sahib!' exactly as my bearer used to call me in the mornings. I fancied that I was delirious until a handful of sand fell at my feet. Then I looked up and saw a head peering down into the amphitheater—the head of Dunnoo, my dog-boy, who attended to my collies. As soon as he had attracted my attention, he held up his hand and showed a rope. I motioned, staggering to and fro the while, that he should throw it down. It was a couple of leather punkah-ropes knotted together, with a loop at one end. I slipped the loop over my head and under my arms; heard

Dunnoo urge something forward; was conscious that I was being dragged, face downward, up the steep sand-slope, and the next instant found myself choked and half-fainting on the sand-hills overlooking the crater."

And then Mary broke in. We were lying in a sunny warm spot on an open hillside a little way off the road, and I was reading aloud from a favorite author.

"That is a fairy story," said Mary, "and I thought we were not going to read any more fairy stories now that I am grown up."

Mary's idea of being grown up is to be more than three feet eleven inches high and to have her hair no longer in two braids.

"Not exactly a fairy story," I replied. "For Kipling rather prefers soldiers to fairies and machines to caps of invisibility. Of course, though, he wrote the Mowgli stories."

"But those are not fairy stories," interrupted Mary. "Those were about a real boy and real animals only a long way off and different from ours."

"Ah-um, real? Well, perhaps; anyway, the Mowgli animals seem more real than most real animals. But this story of the sand-pit and the man sliding down into it and not being able to get out isn't impossible at all. Only the other people down in the bottom seem a little unusual."

"No, there can't be any such place," said Mary positively, "and as there can't be any such place, nobody could have slid into it or been in the bottom, and so it is a fairy story. Any story that isn't so is a fairy story."

"Well, that makes it easy to tell a fairy story from the other kinds, and I never knew exactly how before. But I once saw a place much like the sand-pit that Morrowbie Jukes slid into, or that Kipling says he slid into. It is on the side of a

great mountain in Oregon; Mt. Hood its name is. I had climbed far above timber line, that is, above where all the trees and bushes stop because it is too cold for them to live, and there is only bare rocks and snow and ice, and had sat down to rest near a great snowbank a mile long. As I looked back down the mountain I saw a curious yellowish smoke rising in little puffs and curls. I decided to find out about this smoke on my way down; perhaps it was the beginning of a forest fire, and ought to be put out.

"Well, when I got to it there was no fire; the puffs and curls were not smoke. It was a real Morrowbie Jukes pit; a great crater-like hole in the mountain, with its side so steep that the loose volcanic sand and rocks (for the whole mountain is an old volcano) kept slipping down in little avalanches from which puffs and curls of fine yellow dust kept rising and drifting lazily away. If I had made the mistake

of going too close to the edge, I should certainly have started one of these avalanches and gone slipping and sliding, faster and faster, to the very bottom, a thousand feet below."

"My!" said Mary; "and were there horrible people in the bottom, and crows?"

"Well, really, Mary, I couldn't see on account of the dust-smoke."

"Of course there weren't, probably," said Mary thoughtfully and a little wistfully.

"Probably not," I had to reply regretfully.

But a bright thought came to me. I remembered something. Several days before I had tramped along this hillside road near which Mary and I were lying and I had seen—well, just wait. So I said to Mary: "But I know where there is a Morrowbie Jukes pit, several of them, indeed, near here. Sha'n't we go and see them?"

"Why, of course," said Mary rather severely.

"Let us go galloping as Morrowbie Jukes did," said I. So we took hold of hands and as soon as we got out of the chaparral, we went galloping, hop, hop, hoppity, hop, down the road. I must confess that I got out of breath pretty soon and my knees seemed to creak a little. And when a swift motor-car came exploding by, going up the hill, all the people stared and smiled to see an elderly gentleman with spectacles and a long coat hop-hopping along with a yellow-haired red-cheeked little girl in knee skirts. But we don't mind people much! They simply don't know all the things that go with being happy.

Pretty soon—and it was high time, for I had only three breaths left—we came to a place where the road bent sharply around the hillside and was especially broad.

"Now, Mary," I said, "be careful and

don't fall in. I'm afraid I could not get you out."

"Fall in where? Get me out of what?" asked Mary, quite puzzled. She was staring about excitedly, looking most of the time down into the cañon with its spiry redwood trees pushing far up from the bottom. And then suddenly she saw. She flopped down on her hands and knees in the warm sand by the roadside and cried out, "What funny little holes!"

"Why, Mary," I said with pained surprise. "You don't really mean to call these awful Morrowbie Jukes pits 'funny little holes'! That isn't fair after all we've done to find them. Especially after my galloping all the way right to the very edge of this largest one."

As I spoke I pointed it out with the toe of my shoe, but inadvertently filled it all up by poking a couple of tablespoonfuls of sand and dust into it. But size is quite a relative matter, and for the tiny creatures

with whom Mary and I have to deal, the little crater-like holes in the sand of the roadside are large and dangerous pits. We sprawled down on our stomachs among the pits to see what we could see.

Mary saw first. Ah, those bright eyes! My spectacles are rather in the way out-of-doors, I find. But if I keep on getting younger—and I certainly am younger since I got acquainted with Mary—I shall be able soon to leave them at home in my study when I go out to see things.

Mary, then, saw first. What she saw were two very small shining, brown, gently curved, sharp-pointed, sickle-like jaws sticking up out of the loose sand in the very bottom of one of the pits. They moved once, these curved and pointed jaws, and that movement caught Mary's eye.

"It's the dragon of the pit," I cried. "Dig him out!"

So Mary dug him out. He was very spry and had a strong tendency to shuffle

backwards down into the hiding sand. But it takes a keen dragon to get away from Mary, and this one wasn't and didn't.

He was an ugly little brute, squat and hump-backed, with sand sticking to his thinly haired body. But he was fierce-looking for all his diminutiveness. Remember again that whether a thing is big or little to you depends on whether *you* are big or little. This dragon of the sand-pit was little to us. He is terribly big to the ants.

When Mary got him out and had put him down on the sand near the pit, he trotted about very actively but always backwards. He seems to have got so used to pulling backwards against the frantic struggles of his prey to get up and out of the pit, that he can now only move that way. After we watched him a while, we "collected" him; that is, put him into a bottle, with some sand, to take home and

see if we could keep him in our room of live things. Then we turned our attention to another crater. It was about three inches across at the top and about two inches deep; a symmetrical little broad-mouthed funnel with the loose sand-slopes just as steep as they could be. The slightest disturbance, a touch with a pencil-point for example, would start little sand avalanches down the slopes anywhere. It is, of course, easy to see how this horrible pit-trap works. And, in fact, in the very next moment we saw actually how it did work.

A foraging brown ant that was running swiftly over the ground plunged squarely over the verge of the crater before she could stop. She certainly tried hard to stop when once over, but it was too late. Slipping and sliding with the rolling sand-grains, down she went right toward those waiting scimitar-like jaws.

Now, these jaws deserve a word of de-

scription. Because, horrible as they may seem to the unfortunate ants, they are so well arranged for their particular purpose that they must attract our admiration. The dragon of the pit, ant-lion he is usually called, has no open, yawning mouth behind those projecting jaws, as might be expected. Indeed there is no mouth at all, just a throat, thirsty for ant blood! The slender scimitar jaws have each a groove on the concave inner side, and down this groove runs the blood of the struggling victim, held impaled on the sharp points of the curving mandibles. The two fine grooves lead directly into the throat, and thus there is no need of open mouth with lips and tongue, such as other insects have.

"But see," cried Mary, "the ant has stopped sliding. It is going to get out!"

Ah, Mary, you are not making allowance for all the resources of this dreadful dragon of the pit. Not only is the pit a nearly perfect trap, and the eager jaws at the

bottom more deadly than any array of spikes or spears at the bottom of an elephant pit, but there is another most effective thing about this fatal dragon's trap, and that is this: it is not merely a passive trap, but an active one. Already it is in action. And Mary sees now how hopeless it is with the ant. For a shower of sand is being thrown up from the bottom of the pit against the ant and it is again sliding down. The dragon has a flat, broad head and powerful neck muscles, and has wit enough to shovel up and hurl masses of dry sand-grains against the victim on the loose slopes. And this starts the avalanche again, and so down slides the frantic ant.

What follows is too painful for Mary and me to watch and certainly too cruel to describe. But one must live, and why not ant-lions as well as ants? If truth must be told, many ants have as cruel habits and as bloodthirsty tastes as the

ant-dragon. Indeed, more cruel and revolting habits. For ants have a gastronomic fondness for the babies of other ants, which is a fondness quite different from that which they ought to have. It means that they like these babies—to eat. Some communities of ants, indeed, spend most of their time fighting other communities just to rob them of their babies, which they carry off to their own nests and use in horrible cannibalistic feasts.

Mary and I had seen enough of the Morrowbie Jukes pits. So we went back to our little open sunny spot in the chaparral on the hillside and lay quiet and silent for a long time. Then Mary murmured, "I wonder how the ant-lion digs its pit."

"I can tell you, Mary," I replied. "For a man who once saw one digging told me. It is this way: First he makes a circular groove the full circumference of the top of the pit. Then he burrows into the sand inside of the groove and piles sand-grains

on top of his flat, horny, shovel-like head with his fore feet. This sand he tosses over the groove so that it will fall outside. He works his way all around the groove, doing this over and over, and then makes another groove inside the first, and digs up and tosses the sand out as before. And so on, groove after groove, each inside the one made before, thus gradually making a conical pit with the sides as steep as the loose sand will lie. The pit must always be made in a dry sandy spot, and is usually located in a warm sunny place at the foot of a large rock. This man said that it is easy to get the ant-lions to dig pits in boxes of sand in the house, and so we can try with our 'collected' fellow."

Mary was silent some moments. Then she said softly, "But how will he get anything to eat?"

"Why," said I, "of course we can give him—" Mary looked up at me in a special way she has. I go on, more slowly,

but still without very much hesitation: "But, of course, we sha'n't do that, shall we?"

And Mary said quietly: "No, we sha'n't."

We rested our chins on our hands and lay still, looking down over the chaparral-covered hillside and far out across the hazy valley. On the distant bay were little white specks, small schooners that carry wood and tan-bark and hay from the bay towns to San Francisco; and across the blue bay lifted the bare, brown mountains of the Coast Range, with always that gleaming white spot of the Observatory a-tiptop of the highest peak. It was a soft, languid, lazy day. Such a peace-giving, relaxing, healing day! And we were so enveloped by it, Mary and I, that we simply lay still and happy, with hardly a word. I had, of course, intended to give Mary an informing lecture about how the ugly, horrid ant-lion finally stops preying on ants and rolls himself up in a neat little silk-and-

sand ball, and changes into a beautiful, slender-bodied, gauzy-winged creature without any resemblance at all to its earlier incarnation. But I didn't. It was too fine a day to spoil with informing lectures.

And so Mary and I lay still and happy. Finally it was time to go. As we went down the road we passed again the place of the pits, and Mary looked once more at the neat little craters with their patient waiting jaws at the bottom.

"I wonder," she said, musingly, "if Mr. Kipling ever saw an ant-lion pit."

"I wonder," said I.

ARGIOPE · OF · THE · SILVER
SHIELD

ARGIOPE OF THE SILVER SHIELD

ARGIOPE of the Silver Shield is the handsomest spider that Mary and I know. Do you know a handsomer? Or are you of those who have prejudices, and hold all spiders to be ugly, hateful things? We are so sorry for you if you are, for that means you can never enjoy having a pet Argiope. The truth is, Mary and I like clever and skillful people, but when we can't find that kind, we rather prefer clever and skillful spiders and wasps or other lowly beasties to the other sort of people, which shows just how far a fancy for nature may lead one.

It *is* rather bad, of course, to prefer to chum with a spider, even such a wonderfully handsome and clever one as Argiope,

instead of with a human soul. But that isn't our situation exactly. We prefer human souls to anything else on earth, but not human stomachs and livers and human bones and muscles and sick human nerves. And, someway, too many people leave on one an impression of bowels or sore eyes rather than one of mind and soul. So we rush to the fields or woods or roads after such an experience and live a while with the keen bright eyes, the sensitive feelers, the dexterous feet and claws and teeth, and the sharp wits of the small folk who, while not human, are nevertheless inhabitants and possessors of this earth, side by side with us, and are truly our blood-cousins, though some incredible number of generations removed.

Mary and I scraped acquaintance with our Argiope in a cypress-tree. That is, Argiope had her abiding-place there; she was there on her great symmetrical orb-web, with its long strong foundation lines,

its delicate radii and its many circles with their thousands of tiny drops of viscid stuff to make them sticky. In the center was the hub, her resting-place, whence the radii ran out, and where she had spun a broad zigzaggy band of white silk on which she stood or sat head downward. Her eight long, slender, sensitive legs were outstretched and rested by their tips lightly on the bases of the taut radii so that they could feel the slightest disturbance in the web. These many radii, besides supporting the sticky circles or spiral, which was the real catching part of the web, acted like so many telegraph lines to carry news of the catching to waiting Argiope at the center.

I have said that Mary and I think Argiope of the Silver Shield the most handsome spider we know. There are, however, other Argiopes to dispute the glory with our favorite; for example, a golden-yellow-and-black one and another beautiful silver-

and-russet one. Other people, too, may fancy other spiders; perhaps the little pink-and-white crab-spiders of the flower-cups, or the curious spiny Acrosomas and Gasteracanthas with their brilliant colors and bizarre patterns and shape. Others may like the strawberry Epeira, or the diadem-spider, or the beautiful Nephilas. There are enough kinds and colors and shapes of spiders to satisfy all tastes. But we like best and admire most the long-legged, agile, graceful Argiopes, and particularly her of the silver shield. Her full, firm body with its flat, shield-shaped back, all shining silver and crossed by staring black-and-yellow stripes, the long tapering legs softly ringed with brown and yellow, the shining black eyes on their little rounded hillock of a forehead, and the broad, brown under body with eight circular silver spots; all go to make our Argiope a richly dressed and stately queen of spiders. But the royal consort—O, the less said of him, the

better. A veritable dwarf; insignificant, inconspicuous and afraid for his life of his glorious mate. How such a queen could ever—but there, how tiresome, for that is what gets said of most matches, royal or plebeian.

Mary and I brought Argiope in from her home in the cypress-tree and put her in a fine, roomy, light and airy cage, where she could live quietly and unmolested by enemies, and where we could see to it that she should not lack for food. There are many of the small creatures with which we get acquainted that do not object at all to being brought into our well-lighted, well-ventilated, warm vivarium—that means live-room. Creatures of sedentary habits, and all the web-making spiders are of course that, ought not to object at all and usually do not seem to. For they get two things that they cannot be sure of outside: protection and plenty of food. Argiope seemed perfectly content and settled right down to

spinning a glistening new web, a marvel of symmetry and skillful construction, in her roomy cage, and in a day or two was seated quietly but watchfully on the broad-banded hub in the center, with her toes on her telegraph lines, ready for good news. It was, of course, our duty to see that she was not disappointed.

The message she wanted was from some struggling fly fastened anywhere in the broad expanse of web. So we tossed in a fly. It buzzed about a moment, then blundered into the web which it shook violently in its struggle to escape. Argiope rushed at once out upon the web.

"How can she run about on the sticky web without getting caught, too?" interrupts Mary.

I think a moment, then with some dignity reply: "Pretty soon, please, Mary."

Argiope, I repeat, rushed at once out upon the web, seized the fly in her jaws and ran back to the hub with it, where she

appeared to wet it all over, squeeze it into a ball and then proceed to feed upon it, holding and manipulating it skillfully all the time in her jaws. Evidently Argiope was very hungry, for as you will see, this is not her usual way of taking care of her prey.

"Now, Mary, what was it you asked?"

"Oh, just how the spider can run around so fast on the web without sticking to it and getting caught or tearing it all to pieces."

"Ah,—ah, yes. Well, Mary, I don't know! that is, exactly; or, well not even very close to exactly. But she does it, you see."

"Yes, I see," said Mary, demurely, and —can it be that Mary is slightly winking one eye? I do hope not.

"Of course you know, Mary, that the web is made of two kinds of silk or rather two kinds of lines? Oh, you didn't know?" Mary has shaken her head.

"Well it is," I continue, with my usual

manner of teacher-who-knows somewhat restored again. "The foundation lines, the radii and a first set of circles are all made of lines without any sticky stuff on them. As you see"—and I touch my pencil confidently to a radius, with the manner of a parlor magician. "Then the spider, on this foundation, spins in another long spiral, the present circles of the web, which is liberally supplied with tiny, shining droplets of viscid silk that never dries, but stays moist and very sticky all the time. This is the true catching part of the web."

"We surely must watch her spin a web sometime," breaks in eager Mary.

"We certainly must," say I, and continue. "Now perhaps when Argiope runs out on the web from her watching-place at the hub, she only puts her long delicate feet on the unsticky radii. Or perhaps her feet are made in some peculiar way so that they do not stick to the circles. As a matter of fact, a spider's foot is remarkably fash-

ioned, with curious toothed claws, and hosts of odd hairs, some knobbed, some curved and hook-like, and some forming dense little brushes. But after all, Mary, the truth is, I don't know really how it is that spiders can run about over their webs without getting stuck to them."

After my long discursus about web-making and spider's feet, it seemed time to give Argiope another fly. Indeed her bright little black eyes seemed to Mary to be shining with eagerness for more fly, although she still had the remains of the first one in her jaws—gracious, Argiope's jaws, please, not Mary's!

So we tossed in another fly. We hope you won't think this cruel. But flies are what Argiope eats, and if she was out in the garden, she would be catching them, and, what is worse, they would not be the disgusting and dangerous house-flies and bluebottles that we feed her, but all sorts of innocent and beautiful little picture-winged

flower-flies and pomace-flies and what not. House-flies and stable-flies and bluebottles are truly dangerous because they help spread human diseases, especially typhoid fever. So if we are to live safely they should be killed. Or, better, prevented from hatching and growing at all.

So we tossed in another fly. Argiope immediately dropped the nearly finished first fly into the web, ran out to the new one and pounced on it, seizing it with her fore legs. Then she doubled her abdomen quickly underneath her and there issued from the spinnerets at its tip a jet, a flat jet of silk, which was caught up by the hind feet and wrapped around the fly as it was rolled over and over by the front feet. She tumbled it about, all the time wrapping it with the issuing band of silk, until it was completely enswathed. Then she left it fastened in the web, went back to the hub, and resumed her feeding on the first fly. But soon she finished this entirely, dropped

the wreck out of the web and went out and got the second fly, bringing it back to the hub to eat.

"But why," asked Mary, "does Argiope wrap the fly up so carefully in silk? Why not just kill it by biting, and then leave it in the web until she wants it?"

"Perhaps," I answer, "she wants to make it helpless before she comes to close quarters with it. You notice she holds it away from her body with her fore feet and pulls the silk band out far with her hind feet so that her body does not touch the fly at all while she wraps it. Perhaps she is not sure that it isn't a bee or some other stinging insect. It buzzes loud enough to make me think it a bee."

So Mary and I decided to try some experiments with our Argiope to find out, if possible, first, if she could tell a bee from a fly, and second, if so, whether she treated it differently, and third, why she wraps her prey up so carefully before coming to

too close quarters with it. We feel quite proud of these experiments because we seemed to be doing something really scientific; and we know that Experimental Zoology, that is, studying animals by experimenting with them, is quite the most scientific thing going nowadays among professional naturalists. So here are our notes exactly as we wrote them during our experimenting. This is, of course, the correct manner for publishing real scientific observations, because it gives the critical reader a chance to detect flaws in our technique!

OUR NOTES ON THE BEHAVIOR OF ARGIOPE

"Nov. 18, 4:45 P.M.; released a fly in the cage. The spider pounced upon it, seized it with fore and third pair of legs, threw out a band of silk and enswathed it, tumbling it over and over with her hind feet about thirteen times, hence enswathed it in thirteen wrappings of silk. The fly was

then disconnected from the web, the spider making but little attempt to mend the gap. It was carried to the hub and eaten. While the feast was going on, a honey-bee [with sting extracted; we didn't want to run any risks with Argiope!] was liberated in the cage. As soon as it touched the web, the spider was upon it, throwing out a band of silk in a sheet a quarter of an inch broad. ['Drawing out' would be more accurate, for the spinnerets cannot spurt out silk; silk is drawn out and given its band character by lightning-like movements of the comb-toothed hind feet.] With her hind legs Argiope turned the bee over and over twenty-five or twenty-six times, thus enswathing it with twenty-five or twenty-six wrappings of the silken sheet.

"No sooner was the bee enswathed than a second bee was liberated in the cage and caught in the web. This was treated by the spider like bee No. 1.

"Nov. 20, 8:15 A.M.; Argiope perfectly

still in center of hub, feeding on bee No. 2. The only thing that reveals the feeding is a slight moving of the bee's body as the juices are sucked up. Remains of bee No. 1 dropped to the bottom of the cage.

"Fed all day, 8:15 A.M. to 5 P.M., on bee No. 2.

"At 2:30 P.M., a box-elder bug, which is very ill-smelling, was thrown into the web. Argiope did nothing for three minutes, then went out on the web to it and wrapped, making five complete turns; then went away. Probably not hungry, as she has had two bees and a fly in three days.

"Nov. 21, 8:15 A.M.; box-elder bug finished during last night. Old web replaced by a new one with twenty-nine radii, eleven complete spirals and several partial spirals. The hub is formed of fine irregular webbing about an inch and a half in diameter, without the viscid droplets that cover the spirals. An open space of about a half-

inch intervenes between the hub and the beginning of the spirals.

"4:30 P.M.; liberated a fly in the cage. Argiope pounced upon it and began to eat immediately, not taking time or trouble to enswath it.

"While the fly was being devoured, we liberated a strong-smelling box-elder bug in the cage. It flew into the web. Argiope, by a quick movement, turned on the hub toward the bug and stood in halting position for eight seconds, then approached the bug slowly, hesitated for a second or two, then wrapped it about with five wrappings, halted again, and finally finished with five more wrappings. The bug was then attached to the web where it had first touched, the spider passing back to the center and resuming her meal.

"When the fly was finished, Argiope walked over to the bug, grasped it in her mandibles, walked up to the hub, turned herself about so that her head was down-

ward, manipulated the bug with her fore and third pair of feet until it seemed to be in right position for her with reference to the hub of the web, and began to feed.

"5 P.M.; bee liberated in cage *with sting not extracted.* Argiope leaped instantaneously to the spot where it was caught, enswathed it with great rapidity thirty-seven times, then bit at it, and enswathed it five times more, making forty-two complete wrappings in all, then left it fastened in the web and resumed feeding upon the bug. All the time she was wrapping it, Argiope kept her body well clear of the bee's body, the spinnerets being fully one-half an inch from the bee, making the broad band of issuing silk very noticeable. In biting it, which she seemed to do with marked caution, she of course had to bite through the silken covering.

"A few minutes later a second bee, with sting, was liberated in the cage, caught in the web and rapidly pounced on by the

spider. As before, she turned it over and over with great rapidity, using apparently all of her legs. She enswathed it fifty times, bit it, and then wrapped it with five more silken sheets, making fifty-five wrappings in all. Leaving it hung to the web, she went back to the bug.

"Before Argiope had reached the bug, bee No. 3 was caught in the web at the exact spot where bee No. 2 was hung up. In its efforts to disentangle its feet, it shook the whole web violently. In spite of the violent vibration of the web, Argiope pursued her course to the bug at the hub of the web, adjusted herself with head downward, and resumed feeding.

"Query: Did Argiope think the web-shaking due to futile struggles of the well-wrapped bee No. 2, and hence needing no attention?

"Vibration of the web continued. After several seconds had elapsed, Argiope seemed suddenly to realize that her efforts were

called for out on the web, for she pounced down as rapidly as before and rolled and tumbled *both bees together*, enswathing both in the same sheet of silk, never stopping until she had given them fifty-five wrappings. After biting twice, she wrapped them with five more turns, bit again, and wrapped again with seven more turns, making sixty-seven in all. Argiope then returned to her bug.

"Query: Does Argiope distinguish bees from flies?

"Further query: Does Argiope distinguish bees *with stings* from bees with *stings extracted?*

"Nov. 22, 9:45 A.M.; Argiope feeding at hub on bees Nos. 2 and 3 introduced into cage yesterday afternoon. With her right second leg she holds taut a line connected with bee No. 1.

"10:25 A.M.; packet dropped to the bottom of the cage, the juices of only one of the bees having been sucked out. The

web is constructed at an angle so that anything dropped from the center falls free of it.

"5 P.M.; began feeding again on bee No. 1.

"Nov. 23, 9:30 A.M.; another bee released in cage, caught in web and enswathed approximately thirty turns by Argiope.

"Nov. 25, 8:30 A.M.; the web has been destroyed during the night.

"Nov. 26, Argiope has made an entirely new web.

"Nov. 30, 2 P.M.; gave Argiope a bee with sting. It was wrapped forty-seven times, but not so expeditiously as has been her wont. Later another bee was liberated in the cage, caught and wrapped about forty-five times.

"Dec. 2, 11 A.M.; the body of a live bee was bathed in fluid from the freshly crushed body of a box-elder bug [very malodorous], and the bee liberated in

Argiope's cage, and soon caught in the web. The bee was not very lively and did not shake the web violently, but Argiope rushed to it without hesitation, wrapped it with twenty-five turns of silk and returned to the hub of the web.

"Dec. 3; Argiope stayed all day in the upper part of the web, on foundation lines, with head downward.

"Dec. 5; yesterday Argiope moved down to her normal place on the hub. To-day she is on the hub, but in reversed position [head up], and with legs bent and limp, not straight out and stiffened as usual.

"Dec. 6; Argiope hung all day from foundation lines of upper part of web, in reversed position [head up], with legs limp and bent.

"Dec. 7; Argiope hanging by first and second right legs, from upper part of web; barely alive.

"Dec. 8; Argiope dead."

THE · ORANGE-DWELLERS.

THE ORANGE-DWELLERS

An entire colony of those strange little people, the Orange-dwellers, were killed in our town yesterday morning. And not a newspaper reporter found it out! Just one of the Orange-dwellers escaped, and as Mary and I were the means of saving his life, and are taking care of him as well as we can (Mary has him now on a small piece of orange-rind in a pill box), he has told us the story of his life and something about the other orange-dwelling people. Some of the Orange-dwellers live in Mexico; some live in Florida, and some in California; in fact they are to be found wherever oranges grow. Of course, you have guessed already that the Orange-dwellers are not human beings; they are not really people; they are insects.

The name of the Orange-dweller we had saved, and with whom we became very well acquainted, is so long and strange that I shall tell you merely his nickname, which is Citrinus. The oranges on which Citrinus and a great many of his brothers and sisters and cousins lived grew in Mexico, and when these oranges were ripe, they were gathered and packed into boxes and sent to our town. Imagine if you can the fearful strangeness of it! To have one's world plucked from its place in space, wrapped up in tissue-paper, and packed into a great box with a lot of other worlds; then sent off through space to some other place where enormous giants were waiting impatiently for breakfast! When Citrinus's world reached our town, one of these giants, who is my brother, took it up, and saying, "See, what a specked orange," straightway began unwittingly to kill all of the Orange-dwellers on it by vigorously rubbing and scraping it. For Citrinus and his

companions were the specks! That is all an Orange-dweller seems to be when carelessly looked at; simply a little circular, scale-like, blackish or reddish-brown speck on the shining surface of the orange, his world. You can find the Orange-dwellers almost any morning at breakfast.

When my brother began to scrape off the specks, I hastily interfered, but only in time to save one of the little people, Citrinus, whom, as I have said, Mary has since faithfully cared for. He will soon die, however, for he has lived already nearly three months, and that is a ripe age for an Orange-dweller. But he has had time enough to tell me a great deal about his life, and as it is such a curious story, and is undoubtedly true, I venture to repeat it here to you. As a matter of fact I must confess—still Mary says that *of course* Citrinus can talk, because he talks with other Orange-dwellers later in the story, and so of course can talk to us now.

Citrinus has lived for almost his whole life on the orange on which we found him. His mother lived on one of the fragrant leaves of the tree on which the orange grew. She was, as Citrinus is now, simply a reddish-brown circular speck on the bright-green orange-leaf; and because she couldn't walk, she had to get all her food in a peculiar way. She had a long (that is, long for such a tiny creature), slender, pointed hollow beak or sucking-tube, which she thrust right into the tender orange-leaf, and through which she sucked up the rich sap or juice which kept flowing into the leaf from the twig it hung on. She had thus a constant supply of food always ready and convenient; whenever she was hungry she simply sucked orange-sap into her mouth until she was satisfied. This is the way all the Orange-dwellers get their food, the very youngest of the family being able to take care of itself from the day of its birth. They never taste any other kind

of food but the juice from the leaf or twig or golden orange on which they live.

Citrinus is one of a large number of brothers and sisters, more than fifty indeed, who were hatched from tiny reddish eggs which the mother laid under her own body. Before laying the eggs, Citrinus's mother had built a thin shell or roof of wax over her back, and after the eggs were laid she soon died and her body shriveled up, leaving the eggs safely housed under the waxen roof. When the baby Orange-dwellers were hatched, each had six legs and a delicate little sucking-beak projecting from his small plump body. Citrinus and his brothers and sisters scrambled out from under the wax shell and started out each for himself to explore the world. First, however, each thrust his beak into the leaf and took a good drink of sap. Then they were ready to begin their journeying. But a terrible thing happened!

Just as Citrinus was pulling his beak out

of the soft leaf, he saw a great six-legged beast, in shape like a turtle, with shining red-and-black back and fearful snapping jaws. On each side of its head, which it moved slowly from side to side, it had an immense eye, which looked like a hemispherical window, with hundreds of panes of glass in it. The beast's legs were large and powerful, and on each foot there were two claws, each of them as long as the whole body of Citrinus. Truly this was an appalling sight, and all of the little Orange-dwellers ran as fast as they could, which, unfortunately, wasn't very fast. The beast leisurely caught up in its great jaws one after another of Citrinus's brothers and sisters, and crushed and tore their tender bodies to pieces and ate them!

Now this beast, which seemed so large to Citrinus, was what is to us a very small and pretty insect, one of the lady-bird beetles. These beetles care for no other food than plump Orange-dwellers and

other equally toothsome small insects; and instead of being sorry for its victims, we are glad it eats them! This seems very cruel indeed, but there are so many, many millions of the Orange-dwellers all sucking the juice of orange-trees that although they are so small, and each one drinks so little sap, yet altogether they do a great amount of damage to the orange-trees, often killing all the trees in a large orchard. So the lady-birds are a great help to the orange-growers.

Little Citrinus escaped from the Beetle by crawling into a small, dark hole in the surface of the leaf; but he was badly frightened. This was his first experience with the terrible dangers of the world, with the struggle for life, which is going on so bitterly among the people of his kind, the insects. For although there would seem to be enough plants and trees to serve as food for all of them, many insects find it easier or prefer to eat other insects than to

live on plant food. Now because the insects which live on plant food do injury to our fruit-trees and vegetables and grain crops by their eating, we call them injurious insects; while we call the insect-eating kinds beneficial insects, because they destroy the injurious insects.

But little Citrinus didn't look at the matter at all in this light. He thought the lady-bird beetle a very cruel and wicked being, and resolved to warn every Orange-dweller he met in his travels to beware of the cruel, turtle-shaped beast with the shining black-and-red back. As he wandered on from leaf to leaf along the tender twigs in the top of the tree, he met many other Orange-dwellers, whom he would have told all about the Beetle, but he found that all of them had had experiences as sad as his; in fact he soon learned that of all the Orange-dwellers who are born, only a very, very few escape the Beetles and other de-

vouring beasts who pursue them. And he was highly indignant when one shrewd Orange-dweller told him that it really was a good thing for the race of Orange-dwellers that so many of them were killed. For, the shrewd Orange-dweller said, if all of us who are born should live and have families, and not die until old age came on, there would soon be so many of us that we should eat all the orange-trees in the world, and then we should all starve to death. And this is quite true.

Finally Citrinus came to a remarkable being, a very beautiful being indeed. It had two long, slender, waving feelers on its head, four large ball-shaped eyes, and, strangest of all, two delicate gauzy wings. This beautiful creature greeted Citrinus kindly and asked him where he was going. Citrinus, who was at first a little afraid of the strange creature, was reassured by its kind greeting, and answered simply, "I don't know. My brothers and sisters were

all eaten by the Beetle; my father and mother I have never seen; and no one has told me where to go."

The stranger smiled a little sadly and said, "That is the common story among us Orange-dwellers. Our fathers and mothers always die before we are born. It is a great pity. Yes, before my little Orange-dweller children are born—"

"What," cried Citrinus, "are you an Orange-dweller; you, who are so different from me?"

"Indeed I am," replied the gauzy-winged creature. "I am an old Orange-dweller. Oh, I know it seems strange to you," he continued, noticing the look of astonishment on Citrinus's face, "but some day you will look just like me. You will have wings, and be able to fly; and will have long feelers on your head to hear and to smell with, and big eyes to see all around you with. You will have some strange experiences, though, before you become like me."

"But as I had started to say, we fathers, and the mothers too for that matter, always die before you youngsters are hatched out of your eggs. Now I shall probably die to-morrow or next day, because I have lived three days already, and that is a long time to live without eating."

Little Citrinus could hardly believe his senses. It was so wonderful. "But why don't you eat," urged Citrinus, who felt very badly to think of any one's going without food for three days. He always took a drink of sap every few minutes.

"Why, how absurd," replied the winged Orange-dweller, "don't you see I have nothing to eat with? No sucking-beak, no mouth at all. When I get my wings and my four eyes, I lose my mouth, and can't eat or drink any more."

This was incredible; but when Citrinus looked at the head of his companion, he saw it was perfectly true. He had no mouth. Citrinus gently waved his little sucking-

beak, to be sure he still had it. Suddenly he began to cry; a sad thought had come to him. "And did my mother starve to death too?" he sobbed.

"Not at all, little one," rather impatiently exclaimed the other. Little Citrinus seemed to know so very little, indeed. "Your mother was not at all like me. When she was full-grown she had no wings, no legs, and no eyes, but she had a very long beak, and could suck up a great deal of orange-sap. If you will listen and not interrupt, I will tell you how we Orange-dwellers grow. When we are hatched from our eggs we are all alike, brothers and sisters. We each have a plump little body, six legs, two eyes, and a sucking-beak to get food with. We walk about for a few days, and finally stop on some nice green leaf or juicy orange, and stick our beaks far in and go to sleep, or do something very like it. We never walk about any more. Indeed, if you are a girl Orange-dweller

you never leave this spot, but live all the rest of your life and die here. However, I am getting too far along in my story. While we are asleep we shed all of our skin, fold it up into a little ball or cushion and put it on our backs, together with some wax which comes out of small holes in our bodies. While shedding our skin we make a great change in our bodies. We lose our legs! So we simply remain where we went to sleep, with our beaks stuck into the leaf, sucking the sap. After a few days we go to sleep again, and again we shed our skins and fold them on our backs. But at this time something even more wonderful than before happens to our bodies. That is, to the bodies of the boy Orange-dwellers. For this time we lose our sucking-beaks, but we regain our six legs, and in addition we get a second pair of eyes, we find on our heads a pair of long, slender, hairy feelers, and, most pleasing of all, we have been provided with a pair of wings.

Our wings are not yet full-grown or ready to fly with, so we still remain quietly in our resting-place for a few days longer, when we shed our skin once more, and then fly away, looking just as I do now. Our sisters, though, when they shed their skins the second time, make no change in their bodies, except to grow larger. They remain with their sucking-beaks thrust into the leaf. They keep increasing the size of the wax scale or shell over their backs, until they are entirely covered by it. Now they look just as your mother did. From above, all one can see is the flat circular wax scale with two spots on it, where the folded-up cast skins are. Underneath the scale lies the Orange-dweller, with its sucking-beak stuck into the sap, but with no legs or wings or long, hairy feelers. After a while she lays a lot of eggs under her body, and then dies. And soon the new family is born. Now this is the way we grow, and all of the wonder-

ful things which have happened to me will happen to you,—if the Beetle does not get you."

With that the winged Orange-dweller flew away, and little Citrinus was left alone, wondering over the strange story. After taking a drink of sap from the leaf on which he was standing, he wandered aimlessly about until he came to a large yellow ball hanging from the branch, which gave out a delightful odor. Scrambling down the slender stem by which it was suspended, he walked out on to the shining surface of the orange; for, of course, that is what the yellow ball was. He tried a drink of sap from the ball and found it delicious. He decided to stay on the ball, the more readily as he was getting rather tired with his long traveling, and a sort of sleepy feeling was coming over him. So thrusting his beak far into the ball, he went to sleep. How long he slept he doesn't know, but when he awoke he could hardly be-

lieve his senses. He had no legs; and on his back there was a thin shell of wax and a little packet. He realized, too, that he was bigger than he was before he went to sleep. Then the strange story told him by the winged Orange-dweller came back to him, and he knew that the stranger had told the truth. The first great change had happened. He was delighted, for he thought it would be very pleasant to have wings and fly about wherever he wished, to see the world.

Suddenly a great shock came: his World trembled, then shook violently, and, with a quick wrench, started to move swiftly through space. Then came a stop, a series of shocks and curious whirlings, and then a filmy-white cloud settled down over it all, shutting out the sunlight and the blue sky. Finally there came a few more shocks and wrenches, and then total darkness and silence. Citrinus had held on to his world all through this, because his beak

was still thrust into the fragrant surface, and now he felt thankful that he had come alive through these series of world catastrophes and convulsions and still had all the food he could possibly use.

After a few days, when Citrinus's world all nicely wrapped in tissue-paper and packed in a box with ninety-nine other similar worlds had traveled a thousand miles, the sunlight came again, and soon after came that greatest danger of all—that danger from which I saved him by staying my brother's hand in its ruthless rubbing off of the specks on his breakfast orange! Now Citrinus and Mary and I are all waiting impatiently for the day when he shall get his beautiful wings and his two pairs of eyes.

THE·DRAGON·OF·LAGVNITA·

THE DRAGON OF LAGUNITA

When Mary and I came to examine our ant-lion dragon the day after our adventures among the Morrowbie Jukes pits, we found him dead in the bottle of sand. Perhaps his haughty spirit of dragon could not stand such ignominious bottling up, or perhaps there wasn't enough air. Anyway, His Fierceness was dead. His cruel curved jaws would seize and pierce no more foraging ants. His thirsty throat would never again be laved by the fresh blood of victims. *Vale* dragon!

But there are more dragons than one in our world. Not only more ant-lion dragons, but more other kinds of dragons. And this is one of the great advantages that Mary and I enjoy in our looking about in

the fields and woods for interesting things. If we were looking for the dragons of fairy stories, we could only expect to find one kind—if, indeed, we could expect to find any kind at all in these days when so few fairies are left. If we *could* find it, however, it would be a monstrous beast in a forest cavern, with scaled body and clawed feet and great ugly head that breathed fire and smoke from its gaping mouth. That would be an interesting sort of dragon to see, we confess, more interesting than the great one, a hundred yards long, that we saw in a Chinese procession in Oakland, with two excited Chinamen jumping about in front of its head and jabbing at its eyes with spears. And more interesting than the one that roars and spits at Siegfried on the stage while the big orchestra goes off into wild clamors of O-see-the-dragon music. But we do not expect ever to find a real fairy-story dragon any more, and so we content ourselves with trying to find as

many different kinds of real dragons as we can in our world of little folk on the campus. These dragons are rather small, but they are unusually fierce and voracious, to make up for their lack of size. And so they serve very well to interest us.

To make up for the death of the ant-lion dragon of the sand-pits, I promised to take Mary to see the Dragon of Lagunita. Or rather the dragons, for there are many in Lagunita, and indeed many in several other places on the campus. Have I explained that Lagunita is a pretty Spanish word for "little lake," and that our Lagunita is just what its name means, and besides is as pretty as its name? There is only one trouble about it. And that is, that every year, in the long, rainless, sun-filled summer, it dries up to nothing but a shallow, parched hollow in the ground, and all the dragons have to move. But this moving is a remarkable performance. For while during the spring the Lagunita

dragons live rather inactively in their lairs under the water, when summer comes they all transform themselves into great flying dragons of the air, and swoop and swirl about in a manner very terrifying to see.

The morning we were to make our journey to Lagunita, I came to Mary's house with a rake over my shoulder.

"But what are you going to do with the rake?" said Mary.

"One doesn't go to seek a dragon without weapons," I replied with dignity. "And a rake is a much more formidable weapon in the hands of a man who knows how to rake than a gun in the hands of a man who doesn't know how to shoot." I am something of an amateur gardener, but not at all the holder of a record at clay pigeons nor king of a *Schützen-verein*. So I carried my rake.

"Then what weapon shall I carry?" asks Mary.

I ponder seriously.

"A tin lunch-pail," I finally reply.

"With luncheon in?" asks Mary.

"Empty," I say.

So we start.

I have already said that Lagunita is a pretty little lake. It lies just under the first of the foothills that rise ridge after ridge into the forested mountains that separate us from the ocean. Indeed, it is on the first low step up from the valley floor, and from its enclosing bank or shore one gets a good view of the level, reaching valley thickly set with live-oak trees and houses and fields. Around the little lake have grown up pines, willows and other beautiful trees, and at one side a tiny stream comes in during the wet season. There is no regular outlet, but the water which usually begins to come in about November keeps filling the shallow bowl of the lake higher and higher until by spring it is nearly bank full and may even overflow. Then as the long dry summer

season sets in, the level of the water grows lower and lower until in August or September there is only left a small muddy puddle crammed with surprised and despairing little fishes and salamanders and water-beetles and the like, who are not at all accustomed to such behavior on the part of a lake. And then a few days later they are all gasping their last breaths there together on the scum-covered, waterless bottom.

But when Lagunita is really a lake, it is a very pretty one, and Mary and I love to go there and sit on the bank under the willows near the horse paddocks and watch the college boys rowing about in their graceful, narrow, long-oared shells. These swift-darting boats look like great water-skaters, only white instead of black. You know the long-legged, active water-skaters or water-striders that skim about over the surface of ponds or quiet backwater pools in streams in summer time?

So Mary and I went to Lagunita with our rake and tin lunch-pail to hunt for dragons. No shining armor; no great two-handed sword; no cap of invisibility. Just a rake and a tin lunch-pail.

"Where, Mary, do you think is the likeliest place for the dragon?" I ask.

Mary answers promptly, "There at the foot of the steep stony bank where the big willow-tree hangs over."

We go there. I grasp my rake firmly with both hands. I reach far out over the shallow water. Then I beat the rake suddenly down through the water to the bottom, and with a quick strong pull I drag it out, raking out with it a great mass of oozy mud and matted leaves. I drag this well up on shore, and both Mary and I flop down on our knees and begin pawing about in it. Suddenly Mary calls out, "I've got one," and holds up in her fingers an extraordinary, kicking, twisting creature with six legs, a big head, and a

thick, ugly body on which seem to be the beginnings of several fins or wings. It has, this creature, two great staring eyes, and stout, sharp-pointed spines stick out from various parts of the body.

"Put him in the lunch-pail," I shout. I had already filled it half-full of water from the lake.

Then I found one; then Mary another, and then I still another. It was truly great sport, this dragon-hunting.

We put them all into the lunch-pail where they lay sullenly on the bottom, glaring at each other, but not offering to fight, as we rather hoped they would.

Then, what to do? These dragons in their regular lairs at the bottom of Lagunita might do a lot of most interesting things, but dredged up in this summary way and deposited in a strange tin pail in the glaring light of day, they seemed wholly indisposed to carry on any performances of dragon for our benefit. So

we decided to take them home, and try to fix up for them a still smaller lakelet than Lagunita; one, say, in a tub! Then, perhaps, they would feel more at home and ease, and might do something for us.

So we took them home. And we fixed a tub with sand in the bottom, water over that, and over the top of the tub a screen of netting that would let air and sunlight in, but not dragons out. Then we collected some miscellaneous small water-beasties and a few water-plants, and put them in, and so really had a very comfortable and home-like place for the dragons. They seemed to take to it all right; we called our new lakelet Monday Pond, because of some relation between the tub and wash-day, I suppose, and we had very good fun with our dragons for several weeks. Think of the advantage of having your dragon right at home! If it is a bad day, or we are lazy, or there may be visitors who stay too long so there is only a little time for

ourselves, how convenient it is to have a dragon—or indeed a whole brood of dragons —right in your study. Much better, of course, than to have to sail to a distant island and tramp through leagues of forest or thorny bushes or over burning desert or among spouting volcanoes to find your dragon, as most princes in fairy stories have to do.

I can't, of course, venture to tell you of all the interesting things that Mary and I saw our dragons do. Two or three will have to do. Or my publisher will cry, "Cut it short; cut it short, I say." And that will hurt me, for he is really a most forbearing publisher, and quite in the way of a friend. The three things shall be, one, eating, and what with; two, getting a new skin, and why; and third, changing from an under-water, crawling, squirmy, ugly dragon into an aerial, whizzing, flashing, dashing, beautiful-winged dragon, and when. Of course one of the most impor-

tant things about any dragon is what and how he eats; and the other most important thing about Mary's and my special kind of dragon is his remarkable change. This was to us much more remarkable than having three heads or even getting a new head every time an old one is cut off, which seems to be rather a usual habit of fairy-book dragons.

The dragons lay rather quietly on the sand at the bottom of Monday Pond most of the time. Sometimes one would be up a little way on the shore, that is, the side of the tub, or clinging to one of the plant-stems. When poked with a pencil,—and we were fearless about poking them, if the pencil were a long one,—they would half-walk, half-swim away. But mostly they lay pretty well concealed, waiting for something to happen. What would happen occasionally was this: a young May-fly or a water-beetle would come swimming or walking along; if it passed an inch away from

the dragon, all right; but if its path brought it closer, an extraordinary "catcher," rather like a pair of long nippers or tongs, would shoot out like a flash from the head of the dragon and seize on the unfortunate beastie. Then the "catcher" would fold up in such a way as to bring the victim against the dragon's mouth, which is provided with powerful, sharp-toothed jaws. These jaws then had their turn. And that was the end of the May-fly.

Mary was rather shocked when she saw the dragon first use its "catcher." She wanted to rescue the poor May-fly. But after all she has got pretty well used to seeing tragedies in insect life. They seem to be necessary and normal. Many insects depend upon other animals for food, just as we do. Only fortunately we don't have to catch and kill our own steer or pig or lamb or chicken. We turn the bloody business over to men who like—well, at least, who do it for us. But in the world of

lower animals each one is usually his own butcher.

Mary soon wanted to see the dragon's "catcher," and so we dredged one out of Monday Pond, and put him on the study-table. As he faced us with his big eyes glaring from his broad heavy head, he looked very fierce. But curiously enough, he didn't seem to have any jaws; nor even a mouth. The whole front of his face was smooth and covered over by a sort of mask, so that his terrible jaws and catching nippers were invisible. However, we soon understood this. The mask was the folded-up "catcher" so disposed that it served, when not in use, actually to hide its own iniquity as well as that of the yawning mouth behind. Only when some small insect, all unsuspecting this smooth masked face, comes close, do the long tongs unfold, shoot out, and reveal the waiting jaws and thirsty throat. A veritable dragon indeed; sly and cruel and ever hungry for living prey.

One day when we were looking into Monday Pond, Mary saw a curious object that looked more like a hollow dragon than anything else. It had all the shape and size of one of the dragons; the legs and eyes and masked face, the pads on the back that looked like half-fledged wings. But there was a transparency and emptiness about it that was uncanny and ghost-like. Then, too, when we looked more closely there was a great rent down the back. And that made the mystery plain. The real dragon, the flesh and blood and breathing live dragon, had come out of that long tear, leaving his skin behind! It was his complete skin, too, back and sides and belly, out to the tips of his feelers and down to his toes and claws.

"But why should he shed his skin? Hasn't he any skin now?" asked Mary.

"Of course he must have a skin. How could he keep his blood in, and what would his muscles be fastened to, for he is

a boneless dragon, and his skeleton is his outside shell, with his muscles fastened to it? So how could he live at all without a skin? He must have a new skin."

And, of course, that was exactly it. He had cast his old skin, as a snake does, and had got a brand-new one. Why shouldn't a dragon change his skin if a snake can?

But Mary is persistent about her "whys," and I was quite ready for her next question, which came after a moment of musing.

"Why should he shed his old skin and get a new one? Is the new one different; a different color or shape or something?"

"No; not a different color or different shape especially, but a different size. The dragon is growing up. He is like a boy who keeps on wearing age-nine clothes until they are too short in the sleeves, too tight in the back, and too high-water in the

legs. Then one day he sheds his age-nine suit and gets an age-eleven one. See?''

''What a funny professor you are! Is that the way you lecture to your classes?''

''Gracious, no, Mary! This is the way: As the immature dragon grows older, his constant assimilation of food tends to create a natural increase in size. But the comparative inelasticity of his chitinized cuticula prevents the actual expansion, to any considerable degree, of his body mass. Thus all the cells of the body become turgid, and altogether a great pressure is exerted outwards against the enclosing cuticular wall. This wall then suddenly splits along the longimesial line of the dorsum, and through this rent the dragon extricates itself in soft and defenceless condition, but of markedly larger size. The new cuticula, which is pale, elastic and thin at first, soon becomes thicker, strongly chitinized and dark. The old cuticle, or exuvia, which has been moulted,

is curiously complete, and is a hollow or shell-like replica of the external appearance of the dragon even to the finest details. How is that, Mary?"

"Very instruct—instructing"—with an effort—"indeed," replies Mary, with grave face. "But I guess I understand the change from age-nine to age-eleven clothes better."

And then we saw the third wonderful happening in our dragon's life that I said we should tell about. We saw one of the dragons getting wings! That is, changing from an ugly, blackish, squat, crawling creature into a glorious long-bodied, rainbow-tinted, flying dragon. Another dragon had crawled up above the water on a plant-stem and was also "moulting its chitinized cuticula." But it was coming out from the old skin in very different shape and color. I had forgotten, when I told Mary that they only changed in size after casting the skin, about the last moulting.

Each dragon casts its skin several times in its life, but the last time it does it, it makes the wonderful change I've already spoken about, from crawling to flying dragon. And it was one of these last skin-castings that was going on now under our very eyes.

I can't describe all that happened. You must see it for yourself some time. How, out of the great rent in the old skin along the back, the soft damp body of the dragon squeezes slowly out, with its constant revelation of delicate changing color and its graceful new shape; how out of the odd shapeless pads on the back come four, long, narrow, shining, transparent wings, with complex framework of fine little veins, or ribs, and thin flexible glassy membrane stretched over them; how the new head looks with its enormous, sparkling, iridescent eyes making nearly two-thirds of it and so cleverly fitted on the body that it can turn nearly entirely around on the

neck. And then how the body fills out and takes shape, and the wings get larger and larger, and everything more and more beautifully colored! All this you will have to see for yourself some time when you have a Monday Pond in your own study, with a brood of dragons in.

"It *is* wonderful, isn't it, Mary? How would you like to see twenty, thirty, forty, oh, a hundred dragons doing this all at once. We can if we want to. All we have to do is to go over to Lagunita some morning early, very early, just a little after sunrise—for that is their favorite time—and we shall see scores of dragons crawling up out of the water on stones, plants, sticks, anything convenient, and sloughing off their dirty, dark, old skins and coming out in their beautiful iridescent green and violet and purple new skins, with their long slender body and great flashing wings. They sit quietly on the stones and plant-stems until the warm rising sun dries them

and their new skins get firm and all nicely fitted, and then they begin their new life, —wheeling and dashing over the lake and among the hills and bushes and above the grasses and grain along the banks. Like eagles and hawks they are seeking their prey. Watch that little gnat buzzing there in the air. A flying dragon swoops by and there is no gnat there any longer. It has been caught in the curious basket-like trap which the dragon makes with its spiny legs all held together, and it is being crushed and chewed by the great jaws. Still a dragon, you see, for all of its new beauty!"

Mary muses. "Not all beautiful things in the world are good, are they?" she murmurs.

"Mary, you are a philosopher," I say.

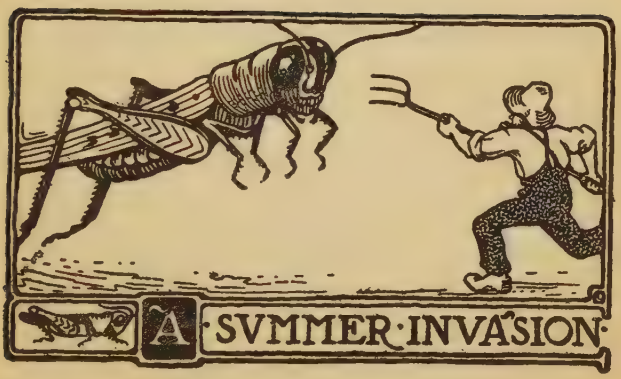
* * * * *

As I read this over I realize quite as keenly, I hope, as you do, my reader, how little there is in this story. And yet finding out this little was real pleasure to Mary

and me. Now we must perforce estimate the pleasures and pains, the likes and dislikes, of other people by our own. And however untrue this estimate may be for any one other person, it must be fairly true for any considerable number of persons. Therefore—and this is the reason for putting down our simple experiences with the insects for other people to read and perhaps to be stirred by to see and do similar things —therefore, I say, other people, some other people, also must be able to get pleasure from what we do.

Now if there is any way and any means of getting clean pleasure into the crowded days of our living, then that way and means should be suggested and opened to as many as possible. Mary and I, you see, have the real proselyting spirit; we are missionaries of the religion of the unroofed temples. And we want all to be saved! So we give testimony willingly of our own experiences, and of the saving grace of our

belief. We have no names for our idols, nor any formulation of our creed. But in various voice and word we do gladly confess over and over again the reality of the happiness that comes to us from our hours with the lowly world that we are coming to know better and better. And any one of these happy hours may contain no more than the little that has been told in this story of the "Dragon of Lagunita," and yet be really and truly a happy hour.


A SVMMER INVASION

A SUMMER INVASION

"ARE you comfortable, Mary?" I ask, "and shall I begin?"

"Yes; in just a minute," Mary replies; "I want to sit so that I can see both ways, Lagunita that way and the brown field with the tarantula holes that way," and she sweeps half the horizon with a chubby hand.

We are half-sitting, half-lying, in the shade at the base of a live-oak on a little knoll back of the campus, whence we can look down on the red-tiled roofs and warm buffy walls of the Quadrangle, and on beyond to the Arboretum with its great eucalyptuses sticking out above the other trees. We can catch glimpses of the bay, too, and of the white houses of the care-

takers of the oyster-beds perched on piles above the water like ancient Swiss lake-dwellers.

Strolling about over the brown field of the tarantula holes and carrying bundles of sticks, and stooping down now and then to strike at the ground with one of the sticks, are several young men, Sophomores by their hats, and one of them with a red jacket on:

"Gowfin' a' the day,
Daein' nae wark ava';
Rinnin' aboot wi' a peck o' sticks
Efter a wee bit ba'!"

Mary recites this in a pretty singsong.

"Why, Mary, where did you learn that?" I ask in surprise.

"From the Scotch lady that I take of."

"Take of! What is it you take of her? I hope not measles or smallpox, or—"

"Why no, of course not. Music. That's what all young ladies take."

"Oh, I see! It *is* catching, isn't it? I have seen some bad cases, especially in small towns. Every young lady, even just girls"—I glance sidewise at Mary—"down with it. But is that what those boys over there are doing? I hope they won't interfere with the tarantulas. They probably don't know what lively times there are at nights in that field. Scores of big black tarantulas racing about, hunting, and hundreds of beetles and things racing about, trying to keep from being eaten. Well, I'd better begin, because we have to get back by luncheon time. I have a most profound lecture to give on Orthogenesis and Heterogenesis to that unfortunate Evolution class at two o'clock."

"I'm all ready," said Mary, looking up at me with confidence. *She* appreciates the kind of lectures I give outdoors, even if the lunch-gorged students don't appreciate my efforts *ex cathedra*.

"Well this summer invasion that I prom-

ised to tell you about happened when I was a boy in a little town in Kansas. It was in a year long ago *now*; before you were born, indeed. And it was an invasion that made more excitement in the state than anything else has since the days of the Civil War.

"I was going down town one day in July to buy some meat for dinner. I was going because my mother had sent me. Naturally this promised to be a very uninteresting excursion. But you never can tell.

"When I had got fairly down to Commercial Street, I saw that all the people were greatly excited. Some were talking loudly, but most were staring up toward the sun, shading their eyes with their hands. Then I heard old Mr. Beasley say: 'That's surely them all right; doggon, they'll eat us up.'

"My heart jumped. Who could be coming from the sun to eat us up? I burst into excited questions. 'Who are coming, Mr. Beasley? I can't see anybody.'

"'Hoppers is comin', boy; see that sort o' shiny thin cloud up there jest off the edge o' the sun? Well, them's hoppers.'

"'But how'll they eat us up, Mr. Beasley? No grasshopper can eat me up.'

"'They'll eat us up with their doggoned terbaccy-spittin' mouths; thet's how. And they'll eat *you* up by eatin' everything you want to eat; thet's how, too. Havin' nothin' to eat is jest about the same as bein' et, accordin' to the way I looks at things.'

"It is evident that Mr. Beasley was a philosopher and a pessimist; that is, a man who sees the disagreeable sides of things, who doesn't see the silvery lining to the dark clouds. In fact, in this particular case Mr. Beasley was seeing a very dark lining to that silvery cloud 'jest off the edge o' the sun.'

"I stared at the thin shining cloud for a long time, wondering if it were really true that it was grasshoppers. People said the silvery shimmer was made by the reflec-

tion of the sunlight from the gauzy wings of the hosts of flying insects. It occurred to me that if the hoppers were just off the edge of the sun, they would all be burned up, or at least have their wings so scorched that they would fall to the ground. However, as the sun is 90,000,000 miles away from the earth, it would take a very long time for the scorched grasshoppers to fall all the way. I guessed that we might have a rain of dead and crippled hoppers about Christmas-time. Anyway there were no grasshoppers now, dead or alive, in the street. And I decided, rather disappointedly, that we probably shouldn't get to see any of the live hoppers at all. Then I asked Mr. Beasley where they came from.

"'Rocky Mountains,' he answered, shortly.

"This seemed a bit steep, for the nearest of the Rocky Mountains are nearly a thousand miles west of Kansas. And to think of grasshoppers flying a thousand miles!

A bit too much, that was. Still I thought I ought to go home and tell the folks. But mother interrupted me in my picturesque tale with a dry request for the meat. Oh, yes. Oh—well, I had forgotten. So the first disagreeable result for me from the grasshopper invasion of Kansas in the summer of 1874 was a painful domestic incident.

"But Mr. Beasley was right. The grasshoppers had come. Next morning all the boys were out, each with a folded newspaper for flapper and a cigar-box with lid tacked on and a small hole just large enough to push a hopper through cut in one end. The rumor was we were to be paid five cents for every hundred hoppers, dead or alive, that we brought in. As a matter of fact nobody paid us, but we worked hard for nearly half a day; that is as long as it was fun and novelty. By noon the grasshoppers were an old story to us. And besides there were too many

of them. Hundreds, thousands, millions,—oh, billions and trillions I suppose. And all eating, eating, eating!

"First all the softer fresher green things. The vegetables in the little backyard gardens; the sweet corn and green peas and tomato- and potato-vines. Then the flowers and the grasses of the front yards. Then the leaves of the dooryard trees. Then the fresh green twigs of the trees! Then the bark on the younger branches!!

"And you could hear them eat! Nipping and crunching, tearing and chewing. It got to be terrible, and everybody so downcast and gloomy. And the most awful stories of what was going on out in the great corn-fields and meadows and pastures. Ruin, ruin, ruin was what the hoppers were mumbling as they chewed.

"And then the reports from the other states in the great Mississippi Valley corn-belt came in by telegraph and letter. Over thousands and thousands of square miles

of the great granary of the land were spread the hordes of hoppers. Farmers and stockmen were being ruined. Then the storekeepers and bankers that sell things and lend money to the farmers. Then the lawyers and doctors that depend on the farmers' troubles to earn a living. Then the millers and stock-brokers and capitalists of the great cities that make their fortunes out of handling and buying and selling the grain the farmers send in long trains to the centers of population. Everybody, the whole country, was aghast and appalled at the havoc of the hopper.

"What to do? How long will they keep up this devastation? Have they come to settle and stay in Kansas and Nebraska and Iowa? What will the country do in the future for corn and wheat and pigs and fat cattle?

"Well, it would be too long a story to tell of how all the entomologists went to work studying the grasshoppers and their

ways: their outsides and insides, their hopping and their flying, their egg-laying and the growth and development of the little hoppers; how the birds, and what kinds, stuffed on them, and the robber-flies and the tachina flies and the red mites and the tiny braconids and chalcids attacked them and laid eggs on them, and their grubs burrowed into them; and everything else about them. But all the time the hoppers kept right on eating; at least they did where there was anything left to eat. Stories were told of their following roots of plants and trees down into the ground to eat them; of how they stripped great trees of bark and branches; of how they massed on the warm rails of railroads at nights and stopped trains; of how enterprising towns by offering rewards to farmers collected and killed with kerosene great winrows and mounds composed of innumerable bushels and tons of grasshoppers.

"Some people of active mind and fertile imagination suggested that if the grasshoppers were going to eat up all our usual food, we should learn to eat *them!* And they got chemists to figure out how much proteids and carbohydrates and hydrocarbons and ash, etc., there was in every little hopper's body. And there was a remarkable dinner given in St. Louis by a famous entomologist to some prominent men of that city, in which grasshoppers were served in several different ways: hopper *sauté*, hopper *au gratin*, hopper *escalloppé*, hopper *soufflé*, and so on. The decision of the guests—those who lasted through the dinner—was that 'the dry and chippy character of the tibiæ was a serious objection to grasshoppers as food for man.'

"But you want to know the end of it Mary, don't you? Well, it was a very simple end. Simply, indeed, that the hoppers went back! Yes, actually, when autumn came they all—that is, all that hadn't been

eaten by birds and toads and lizards, or collected by farmers and burned, or hadn't got walked on by horses and people, or hadn't got studied to death by entomologists—flew up into the air and sailed back to the Rocky Mountains. Or at least they started that way. I never heard if any of them really got all the thousand of miles back. But whereas in the summer they had all been flying southeast, in the fall they all began flying northwest.

"But some of them had laid eggs in the ground in little cornucopia-like packets before dying or flying away. And much alarm was caused by predictions that millions of new hoppers would come out of the ground in the coming spring and eat all the crops while young, even if the old ones or more like them didn't come again in the summer and eat the mature crops. But these predictions were only partly fulfilled. Not many hatched out in the spring, and those that did seemed to be

more anxious to get back to the Rocky Mountains where their brethren were than to eat the Kansas crops. Indeed as soon as the young hoppers got their wings—and that takes several weeks after they come from the egg—they began flying northwest.

"So this remarkable and terrible invasion was over. And all the poor farmers, and the bankrupt or about to be bankrupt storekeepers and bankers and the idle lawyers and doctors and the terrified capitalists and the hard-studying entomologists drew a long breath of relief together."

"But have the hoppers come back any time since 1874?" asks Mary.

"No, that was the last invasion. There had been earlier ones, though, one or two of them just as bad as the Centennial-year one. Indeed Kansas was called the Grasshopper State on account of these terrible summer invasions. There was a bad one in 1866 and several before that. The grass-

hoppers of 1874 and 1875 cost the farmers of the Mississippi Valley at least fifty millions of dollars in crops eaten up."

"But what made them come to Kansas? Why didn't they stay in the Rocky Mountains? It's much more beautiful and interesting there than in Kansas, isn't it?"

"Much, Mary. But it probably wasn't a matter of scenery with these tourist hoppers. Much more likely a matter of food. In those days there were no farmers with irrigated fields on the great plateaus along the eastern base of the Rocky Mountains in Colorado and Wyoming. Nothing much but sage-brush and not overmuch of that grew there. And probably there simply wasn't enough food for all the hoppers. So in seasons when there were too many hoppers or too little food—and if there was one, there was also the other—they flew up into the air, spread their broad wings and sailed away on the winds from the northwest for a thousand miles to Nebraska and

Kansas and Texas. And that made an invasion."

"But, then, why didn't they stay there, where there were cornfields and wheat-fields and vegetables?" persisted Mary.

"Mary, I can only tell you what the hard-studying entomologists decided about this, and published along with all the other things they found out, or thought they did, in several big volumes devoted to the grasshoppers. They found out that the hoppers tried to go back because they couldn't stay! That is, odd as it may seem, either the climate or the low altitude or something else uncomfortable about Kansas and Missouri disagrees with the Rocky-Mountain hoppers and they can't live there permanently. They can't raise a family there successfully; at least it doesn't last for more than one generation. They have to live on the high plateaus of the northern Rockies, but they can get on very well for a single summer away from

home. Then they must get back if they can. And so it was that the hoppers that came to Kansas solved the weighty problem and relieved the great anxiety of the farmers and the whole country in general as to what was to become of the great grain-fields of the Middle West, by going back home again.

"And will they ever evade Kansas again?"

"That, Mary, is not a question for a stick-to-what-is-known scientific person like me to answer. But as ever since farms and grain-fields and vegetable gardens have been established on the Rocky Mountain plateaus by the farmers who keep moving west, the hoppers haven't come back to Kansas, and as this is probably because they have enough food at home in these Colorado and Wyoming fields, I should be very much surprised if they ever come back to Kansas again."

"Yes, but weren't you surprised that

first time you saw them in the year so long ago?"

"Mary, you are a quibbler. Well, then, I'll say that I don't think they'll ever make another foreign invasion. There!"

It is time for us to stroll home for luncheon. As we get up from under the live-oak, a stumpy-bodied little grasshopper whirs away in front of us.

"To think that such a little thing could make a summer evasion one thousand miles away from here," said Mary.

"Much littler things have done much bigger things," I reply, with my serious manner of lecturer-after-luncheon.

A·CLEVER·LITTLE·BROWN
ANT

A CLEVER LITTLE BROWN ANT

We were sitting in the warm sun on the very tip-top of Bungalow Hill. This is a gentle crest that rises three hundred and fifty feet above the campus level, and gives one a wonderful view far up and down the beautiful valley and across the blue bay to the lifting mountains of the Coast Range. Square-shouldered old Mt. Diablo standing as giant warder just inside the Golden Gate, the ocean entrance to California, looms massive and threatening directly to our east, while to its south stretches the long brown range with its series of peaks, Mission, Mt. Hamilton, Isabella, and so on, way down to the twin Pachecos that guard the pass over into the desert. In the north rises Mt. Tamalpais, the wonderful fog mountain that looks down on the busy life

at its feet of San Francisco, and its clustering child cities growing up rapidly these days, while the mother is lying ill of her wounds by earthquake and conflagration. To the south stretch the long orchard leagues of the Santa Clara Valley, with the little white spots of towns peeping out from the massed trees so jealous of every foot of fertile ground. And to the west—ah, that is the view that Mary and I lie hours long to look at and drink in and feel, —"our view," we call it.

We think we see things there that other people cannot. We see these things especially well when we half-close our eyes, and describe what we see in a sort of low, drowsy, monotone murmur. Then the fringe of towering spiry redwoods along the crest of the mountain range that lies between us and the great ocean and lifts its forested flanks full two thousand feet above us, becomes a long row of giants' spears sticking up above the battlements

of a mighty castle. And the shadow-filled somber slashes and tunnel-like holes of the dropping cañons are the great entrances and doors to this castle. At our feet the broad shallow cañada that stretches all along the foot of the mountains and was made ages ago by some tremendous earthquake seems, seen through our half-closed eyes, to be full of water and to be really a broad moat shutting off all access to the castle.

The giants themselves we have never yet seen. But some day when the light is just right, and they are stirring themselves to look out at the world, we probably shall. Perhaps if we had been up here that day not long ago when the last earthquake came, we should have seen the giants looking out to see who was knocking at their gates. For it will take an earthquake's knocking ever to be felt in the heart of that mountain castle where the giants keep themselves.

The air was so clear this day that it seemed as if we could see each individual great redwood, each red-trunked, glossy-leaved madroño, each thicket of crooked manzanita and purpling Ceanothus, on the whole mountain side. Straight across through the clear blue-tinged atmosphere above the cañada to the shoulders and cañons, the forests and clear spaces and chaparral of the mountain flanks, we look. And it rests our eyes that are so tired of reading. It is good to be a-stretch on sun-bathed Bungalow Hill this afternoon in October. The rains will be coming in a few weeks and then we can't be out so much. Or at any rate we can't lie close to the warm, brown, dry earth as we can now. But the rains will bring the fresh, green grasses and the flowers. If they come early enough the manzanitas will have on their little trembling pink-white lily-of-the-valley bells by Christmas-day, and the wild currants will be all green-and-

rose color, with little leaves and a myriad fragrant blossoms.

But Mary has found something. She had turned over a little flattish stone and under it was—life! Living things disturbed in their work, their play, their laying up of riches, their care of their children; little animate creatures revealed in all the intimacies of their housekeeping and daily life.

But they didn't lose their presence of mind, these active, knowing little ants, when the Catastrophe came. There was work to be done at once and wisely. First, the saving of the children; and so in the moment that passed between Mary's overturning of the stone and our immediate shifting into comfortable position on our stomachs, head in hands, for watching, half of the racing workers had each a little white parcel in its jaws and was speeding with it along the galleries toward the underground chambers.

"Ants' eggs," said Mary.

"No," said I. "That's a popular delusion. These little white things are not ants' eggs, but ants' babies. They are the already hatched and partly grown young ants, the larvæ and pupæ, which are so well looked after by the nurse ants. For these young ants are quite helpless, like young bees in the brood-cells in a honey-bee hive. And they have to be fed chewed food, and as they have no legs and so can't walk, they have to be carried from the cool dark nurseries up into the warmer lighter chambers for air and heat every day almost, and then carried back down again. See how gently the nurse ant holds this baby in its jaws; jaws that are sharp and strong and that can bite fiercely and hold on grimly in battle."

And I hand Mary my little pocket-lens through which she tries to look with both eyes at once. She could, of course, if she would keep her blessed eyes far enough

away, but as she persists in holding the glass at the tip of her nose as she has seen me do, and as she cannot shut one eye and keep the other open, as I can, and have done now so many years that I have wrinkles all round the shut-up eye, why, she makes bad work of it. So she hands back the lens with a polite "thank you," and sticks to her own keen unaided eyes. And sees more than I do!

For in the next breath she cries, with a little note of triumph in her voice: "But some of the ant babies *are* walking. See there! And you said they have no legs. I can see them; little stumpy blackish legs sticking out from their soft white body! And some of the ants are carrying these babies with legs; I can see them!"

I squirm around nearer Mary. True enough there are some little white chubby creatures walking slowly around in the narrow runways. But I *know* they cannot be ant larvæ. For ant larvæ have no legs

and simply can't walk. What are they? I get out the little pocket-lens. And the mystery is solved. They are the "ant-cattle," the curious little mealy-bugs that many kinds of ants bring into their nests and take care of for the sake of getting from them a constant supply of "honey-dew." This "honey-dew" which the mealy-bugs make and give off from their bodies is a sweetish syrupy fluid of which almost all ants, even those most fiercely carnivorous, are very fond. And as the mealy-bugs and plant-lice that make the honey-dew are quite defenceless, soft-bodied, mostly wingless and rather sedentary insects, the bright-witted ants establish colonies, or "herds," of them in their nests, or visit and protect colonies of them living on plants near the ant-nest. Some kinds of ants even build earthen "sheds," or tents, over groups of honey-dew insects on plant-stems. The mealy-bugs are white because they cover their soft little bodies with del-

icate threads or flakes of glistening white wax which they make in their bodies and pour out through tiny openings in the skin.

We watch the busy, excited ants until they have carried all their babies and cattle down into the underground nursery chambers, out of harm's way. Then we put the stone carefully back in place, and roll back again to where we can watch the wonderful mountains in the west. The redwood-fringed crest stands so sharply out against the sky-line that we really can distinguish every tree that lifts its head above the crest, although they are several miles away from us. These great trees, which are the giants' jagged spears, are one hundred and fifty feet high, some of them, and as big around at the base as one of the massive columns in the Cologne Cathedral.

Finally I say, rather lazily, "Mary, shall I tell you about the special way the clever

little brown ant of the Illinois corn-fields takes care of its cattle?"

"Yes, please, if it isn't too long," says Mary.

Mary and I are on perfectly frank terms. We are polite, but also inclined to be honest. And Mary is not going to be an unresisting victim of a garrulous old professor. But Mary need not be afraid that I sha'n't know when I am boring her. We have wireless communication, Mary and I. That's one, probably the principal, reason why we are such good companions. No true companionship can possibly persist without wireless and wordless communication.

"All right," I answer, "here goes, Mary. Say when!"

"I forget how many millions of bushels of corn were raised in the state of Illinois last year, but they were very many. And that means thousands and thousands of acres of corn-fields. Now in all these corn-

fields there live certain tiny soft-bodied insects called corn-root aphids. Their food is the sap of the growing corn-plants which they suck from the roots. Although each corn-root aphid is only about one-twentieth of an inch long and one-twenty-fifth of an inch wide and has a sucking-beak simply microscopic in size, yet there are so many millions of these little insects all with their microscopic little beaks stuck into the corn-roots and all the time drinking, drinking the sap which is the life-blood of the corn-plants that they do a great deal of injury to the corn-fields of Illinois and cause a great loss in money to the farmers.

"So the wise men have studied the ways and life of these little aphids to see if some way can be devised to keep them in check. The aphids live only two or three weeks, but each one before it dies gives birth to about twelve young aphids. Now this is a very rapid rate of increase. If all the young which are born live their allotted

two or three weeks and produce in their turn twelve new aphids, we should have about ten trillion descendants in a year from a single mother aphid. Ten trillion corn-root aphids, tiny as they are, would make a strip or belt ten feet wide and two hundred and thirty miles long!

"Some other kinds of aphids multiply themselves even more rapidly. An English naturalist has figured out that a single-stem mother of the common aphis, or 'green-fly' of the rose, would give origin, at its regular rate of multiplication and provided each individual born lived out its natural life, which is only a few days at best, to over thirty-three quintrillions of rose aphids in a single season, equal in weight to more than a billion and a half of men. Of course such a thing never happens, because so many of the young aphids get eaten by lady-bird beetles and flower-fly larvæ and other enemies before they come to be old enough to produce young.

"However, besides this rapid increase of the corn-root aphids, there is something else that helps them to be so formidable a pest. And this is that they find very good and zealous friends in the millions of little brown ants that also live in the Illinois corn-fields. These swift, strong, brave little ants make their runways and nests all through the corn-fields, and are very devoted helpers of the soft-bodied helpless aphids. For the aphids pay for this help by acting as 'cattle' for the ants.

"This is what Professor Forbes, a very careful and a very honest naturalist, found out about the ants and the aphids. The eggs of the aphids, hosts of shining black, round, little seed-like eggs, are laid late in the autumn. These eggs are gathered by the ants and heaped up in piles in the galleries of their nests, or sometimes in special chambers made by widening the runways here and there. All through the winter these eggs are cared for by the ants,

being carried down into the deeper and warmer chambers in the coldest weather, and brought up nearer the surface when it is warm. When the sunny days of spring begin to come, the eggs are even brought up above ground and scattered about in the sunshine, then carried down again at night. The little ants may be seen sometimes turning the eggs over and over and carefully licking them as if to clean them of dust-particles.

"In the late spring the aphid eggs hatch, and the young must have sap to drink right away. Their little beaks are thirsty for the plant-juices that are their only food. But there are no tender corn-roots ready for them in the fields because the corn has not yet been planted. What, then, shall the hungering baby aphids and their foster-mothers, the little brown ants, do?

"This is what happens. Although it is too early yet for the corn to be growing, there are various kinds of weeds that be-

gin to sprout with the coming on of spring, and two of these, especially, the smart-weed and the pigeon-grass, abundant and wide-spread in all the Mississippi Valley, are sure to be growing in the fields. While the aphids much prefer corn-roots to live on, they will get along very well on the roots of smart-weed or pigeon-grass. So the clever little brown ants put the almost helpless baby aphids on the tender roots of these weeds, and there their tiny beaks begin to be satisfied. Don't you call that clever, Mary?"

"Clever! Gracious!" says Mary. "Do you know Professor Forbes? Is he really —does he always tell the—"

I interrupt. I am sensitive about such questions. I answer rather sharply. "Yes, I *do* know him; and yes, he always tells the truth. Don't interrupt any more, please, for there is still more of the story." Mary is silent.

"Well, the aphids stay on the smart-

weed roots until the corn is planted, which is in about ten days, and the kernels begin to germinate and to send down the tender juice-filled roots. And then the little brown ants take the aphids, now getting larger and stronger, of course, but still too helpless or stupid to do much for themselves except to suck sap, and carry them from the smart-weed roots to the corn-roots—What's that, Mary?"

But Mary had said nothing; just drawn in her breath with a little sound. Still I think it best to remind her that I *do* know Professor Forbes and that he really *does* always tell the truth. In fact, I quote to Mary this honest professor's exact words about this transfer of the aphids from the weed-roots to the corn-roots. This is what he writes in his intensely interesting account of the whole life of these little insects: "In many cases in the field, we have found the young root aphis on sprouting weeds (especially pigeon-grass) which

have been sought out by the ants before the leaves had shown above the ground; and, similarly, when the field is planted to corn, these ardent explorers will frequently discover the sprouting kernel in the earth, and mine along the starting stem and place the plant aphids upon it."

"And the little brown ants do all this so as to get honey-dew from the aphids?" asks Mary.

"Exactly," I reply. "The ants take such good care of the aphids not because they pity their helplessness or just want to be good, but because they know, by some instinct or reason, that these are the insects that, when they grow up, make honey-dew, which is the kind of food that ants seem to like better than any other. Indeed not only the little brown ants alone take care of the corn-root aphids to get honey-dew, but at least six other kinds of ants that live in the Illinois corn-fields do it. But the little brown ants are the most

abundant and seem to give the aphids the best care."

"It is exactly like keeping cows, isn't it," says Mary. "But they don't have to milk them."

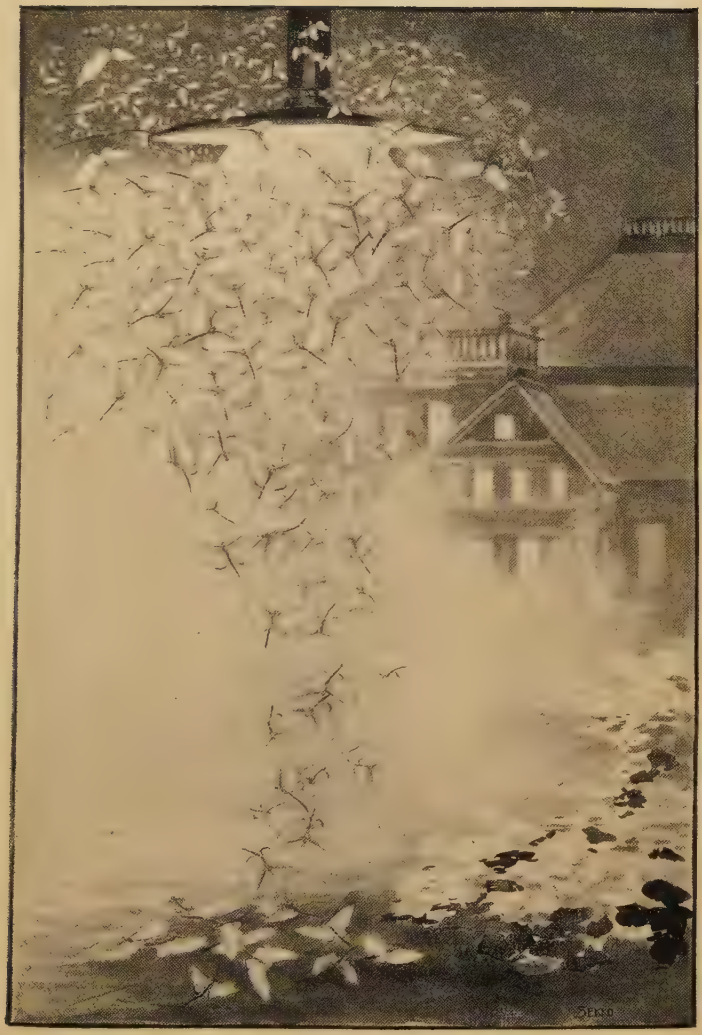
"Well," I reply, "I don't know what you would call it, but some other ants that take care of some other kinds of honey-dew insects seem to have to carry on a sort of milking performance to make them pour out their sweet liquid. The ants have to pat or rub them with their hairy little feelers; sort of tickle them to get them to squeeze out a little drop of honey-dew. The truth is, Mary, if I should tell you the really amazing things that ants do, you simply wouldn't believe me at all. But the next time we go out, I'll take you to see for yourself an ant community right on the campus that does some remarkable things. I'd much rather have you see the things yourself than tell you about them."

"I'd rather, too," says Mary, which isn't

exactly the nicest thing she could say, but I know what she means. It's that seeing is better than being told by anybody.

And then the up-and-down "ding, dang, dong, ding," of the clock-bells begins its little song in four verses that means the end of an hour. And then come the six slow deep calls of the biggest bell that tell what hour it is. It is the hour for us to go home.

AN·HOVR·OF·LIVING·OR·THE DANCE·OF·DEATH



AN HOUR OF LIVING; OR, THE DANCE OF DEATH

"But why didn't he go back if he liked France so much better; and if he had plenty of money?" asked Mary.

"Ah, well, even having plenty of money doesn't always make it possible to do just what we prefer," I say. "The truth is,—if it is the truth, and not just malicious gossip,—it was exactly because he had plenty of money that he couldn't go back. He is supposed to have got that money in some wrong way. Anyway, he didn't seem to care to go back to *la belle France*, but preferred to live solitarily here, and to plant lines of trees and lay out little lakes and build rockwork towers and make terraces and driveways and paths, all in very formal lines, as in the parks at Versailles

and St. Cloud, which were the playgrounds of French kings and the pride of all France."

Mary and I were seated on a curious little cement-and-stone imitation tower-ruin that stuck up out of Frenchman's Pond, which is near the campus, and is a good place for seeing things and getting away from the classroom bells. A long row of scraggly Lombardy poplars stretches away from the pond along an old terraced roadway with a cave opening on it. Around two sides of the little lake is a rockwork wall, and across one end, where the pond narrows, is a picturesque stone bridge of single span. Everything is neglected, and altogether Frenchman's Pond and its surroundings are a good imitation of something old and foreign in this glaringly new and extremely Californian bit of the world. It is a favorite place for us to come when I want to tell Mary stories of the castles on the Rhine. We get a proper atmosphere.

It was so sunny and warm this morning that we had given up chatting and were simply sitting or sprawling as comfortably as we could on the irregular top of our *Aussichtsthurm*. A few flying dragons, some in bronze-red mail, some in greenish blue, were wheeling about over the pond, and a meadow-lark kept up a most cheerful singing in the pasture nearby. It was really just the sort of day and place and feeling that Mary and I like best. We knew we ought, as persevering Nature students, to get down and poke around in the weeds and ooze of the edges of the pond so as to see things. But we didn't want to do it, and so we didn't. That is one perfectly beautiful thing about the way Mary and I study Nature. We don't when we don't want to.

But if we didn't climb down to the live things this day at Frenchman's Pond, they came up to us. One of the flying dragons actually swooped so close to our heads that

we could hear its shining brittle wings crackle, and only a few minutes after, a curious delicate little creature with four gauzy wings, a pair of projecting eyes with a fixed stare, and three long hair-like tails on its body, lit on Mary's hand and walked slowly and rather totteringly up her bare wrist and fore arm. Then without any fluttering or struggling, it slowly fell over on one side and lay quite still. It was dead!

This rather took our breath away. We are only too well accustomed, unfortunately, to seeing death come to our little companions; they do not live long, at best, and then so many of them get killed and eaten. But they usually make some protest when Death approaches. They do not surrender their brief joy of living in such utterly unresisting way as this little creature did. But when I had got my spectacles properly adjusted, I saw what it was that had died so quietly and suddenly.

The little gauzy-winged creature was a May-fly, or ephemera, and life with the May-flies is such a truly ephemeral thing, and death comes regularly so soon and so swiftly, and without any apparent illness or injury intervening between health and dissolution, that we naturalists have ceased to wonder at it. Although this is not because we understand it at all. Far from it. Indeed the death of any creature, except from obvious accident or wasting illness, is one of the mysteries of life. Which sounds rather Irish, but is just what I mean.

But Mary was looking thoughtfully at this dead little May-fly in her hand. It was so soft and delicate of body, had such frail and filmy wings, that it seemed that it must have been very ill-fitted to cope with the hard conditions of insect living, to escape the numerous insect-feeding creatures and to find food and shelter for itself, to be successful, in a word, in the

"struggle for existence"! And in a way, this is quite true. But, in another way, it is not true. For the May-flies, in their flying stage, make up for their frailness and feebleness, their inability to feed—they have really no mouth-parts and do not eat at all in their few hours or days of flying life—by existing in enormous numbers, and millions may be killed, or may die from very feebleness, and yet there are enough left to lay the eggs necessary for a new generation, and that is success in life for them. Nothing else is necessary; their whole aim and achievement in life seems to be to lay eggs and start a new generation of May-flies.

I settled back into a still more comfortable position and said: "Did I ever tell you, Mary, of the May-flies' dance of death I saw in Lucerne once, not far from the old bridge across the Reuss with its famous pictures of our own dance of death? Well, then, we'll just about have time before the

tower-clock calls us home. Do you want to hear about it?"

"Yes, please," said Mary.

"Well, I had been studying in a great university in an old German town all the spring and early summer and had come to Switzerland for my vacation. You know there are splendid mountains there—"

"The Alps," interrupted Mary. "The highest is Mt. Blanc, 15,730 feet above the sea."

How Mary does know her geography!

"And beautiful lakes," I continue. "And the roads are good for tramping, and the hotels cheap. Anyway, the ones the students go to. I had come to Lucerne from Zurich—"

"Noted for its silks and university where women can go," Mary broke in again.

Bless me, what's the use of going to Europe anyway, if you learn everything about everywhere in the grades?

"And had gone straight to the *Mühlenbrücke*," I go on,—"that's the old bridge all covered with a roof that crosses the Reuss only a few rods from where it flows out of the lake; the lake of Lucerne, you know."

"Of course," said Mary.

"For it is on the ceiling of that bridge," I persist, "that these curious old Dance of Death pictures are painted, and I had heard a great deal about them. They show how everybody is dancing through life to his grave. Not very pleasant pictures, Mary."

"Very unpleasant, I should think," says Mary, positively. "I hope you didn't look at them long."

"No, because, for one reason, it was getting too dark to see them. The sun had set behind the Gutsch—that's a pretty hill just west of Lucerne—and the electric lights were already flashing along the lake-shore promenade. You know what a won-

derfully beautiful lake Lucerne is, of course, Mary?"

"Yes; it is unsurpassed in Switzerland, perhaps in Europe, for magnificence of scenery," replies Mary, in level voice.

I resolve to cut geographic information out of any further stories I tell Mary. Do they commit Baedeker to memory nowadays in the schools?

"Exactly," I manage to reply without betraying too much astonishment at this revelation of the American educational method.

"Well, along the shore of this unsurpassed lake at the town of Lucerne there is a broad promenade with trees and benches and electric lights. Behind it are the big hotels all in a curving row, and after dinner all the people come out and stroll about while the band plays. It is a fine sight."

Mary seemed to be getting a little less than interested. She squirmed into a new

position on the rough rockwork and then, looking out over the little pond with its hawking dragons whizzing back and forth, she asked: "What about the May-flies, please?"

I really believe she knew all about the hotels and promenade and the band. What wonderful schools!

"I was coming—I have just come to them," I reply with dignity.

I am a professor and have a certain stock supply of dignity to draw on when necessary. It isn't often necessary with Mary.

"Well, as I came from the covered *Mühlenbrücke* and out on to the lake-shore promenade, I saw a little crowd of people gathered under and about a brilliant arc-light hanging in an open place in front of the great Schweizerhof Hotel. The light seemed to me curiously hazy, and even before I got near the crowd I had made a guess at what was going on. My guess

that it was a May-fly dance of death was quite right. Perhaps it would really be better to call it a 'dance of life,' for it really was sort of a great wedding dance. But it was a dance of death, too, for the dancers were falling dead or dying out of the dizzying whirly circles by thousands. How many hundreds or thousands or millions of May-flies there were in the dense circling cloud about the light, I have no idea. But the air for twenty feet every way from the light was full of them, and the ground for a circle of thirty or forty feet underneath was not merely covered with the delicate dead creatures, but was covered for from one to two inches deep!

"The crowd of promenaders looked on in gaping wonder. Not one seemed to know what kind of creature this was, nor of course anything about what was really going on; that this was all of the few hours of feverish life which these May-flies enjoyed in their winged state, and that they

gave it all up to the business of mating and egg-laying; where they came from, how they had lived before, why they should be here to-night and no other in the whole year, all these things which it seems to me the onlookers ought to have wanted to know, nobody seemed to know, nor anybody seemed particularly to care to.

"But there are places in the world where the people do want to know these things, and a great many more, about the May-flies. One such place is the Thousand Islands in the St. Lawrence River. One day I was sailing down this river among the Thousand Islands, and the acquaintanceship of a small and unusually delicate kind of May-fly was forced on me by the hundreds of them that persisted in alighting on my clothes, my hat, and my hair. They kept walking unsteadily about over my face and hands and the open pages of the book I was trying to read. And they

kept dying, dying, all around. One would light on the outer edge of the page, and before it had walked across to the beginning of a sentence, it would die and its body would slide gently down into the back of the book and—be a book-marker!"

"That's not a very nice way to talk about the poor little dead May-flies," said Mary, rather seriously.

"It isn't, Mary, I know," said I. "But we've got to relieve the gloom of this tale someway, don't you think? There is too much wholesale death in it to suit my publisher! And so I am trying to introduce a little jocularity into it, don't you see, Mary?"

"People are not supposed to be very funny at funerals," said Mary, severely. "Where did the little Thousand Islands May-flies come from, and why do the people there want to know about them?"

"Because there are so many May-flies

that they are a great pest. Not by eating crops—for there aren't any, I suppose, and the May-flies don't eat anything anyway—nor by carrying malaria, but just by living and dying all over; everywhere in one's summer cottage, down on the river-bank where you are watching the sunset, under the trees when you are lying in your hammock and trying to read, in your rowboat when you are paddling about to visit your neighbors on other islands. To be walked on and died on by hundreds and hundreds of little flies, and all the time, grows to be very uncomfortable. So the May-flies or river-flies or lake-flies as they are variously called are cordially hated by all the Thousand-Islanders and the St. Lawrence-Riverers. And the people want to know about where they come from, and how they live, and all about them, indeed, so as to try to find some way to be rid of them."

"And do you know where they come

from, and how they live, and all about them," asks Mary, with a slightly roguish manner, I fear.

"Well, I know something. In the first place, after the dance of death, the few that don't die fly out over the lake or river or pond and drop a lot of little eggs into it. Then they die happy—if May-flies can be happy. Mind you, I don't say they can. We are the only animals that we know can be happy. And we mostly aren't. From the eggs hatch young May-flies without wings or long thread-like tails, but just little, flat, under-water creatures with gills along the sides so they can breathe without coming up to the surface. Some kinds burrow into the mud at the bottom, some kinds make little tubes or cases in which to live, while others stay mostly on the under side of stones. They eat little water-plants or broken-up stuff they find in the water, although some eat other little live animals, even other young

May-flies. And many of them get eaten themselves. They are favorite food of the under-water dragons. You remember, don't you, Mary, how our dragons of Lagunita would snap up the young May-flies in Monday Pond?

"Well, these young May-flies—the ones that don't get eaten by dragons, stone-flies, water-tigers, and other May-flies—grow larger slowly, and wing-pads begin to grow on their backs. In a year, maybe, or two years for some kinds, they are ready for their great change. And this comes very suddenly. Some late afternoon or early evening thousands of young May-flies of the same kind, living in the same lake or river, swim up to the surface of the water, and, after resting there a few moments, suddenly split their skin along the back of the head and perhaps a little way farther along the back, and like a flash squirm out of this old skin, spread out their gauzy wings and fly away. They

do this so quickly that your eye can hardly follow the performance."

"And then they all fly to the light and begin their dance of death," breaks in Mary.

"No, wait; they are not yet quite ready for that. First, they do a very unusual thing; something that no other kinds of insects have ever been seen to do. This is it: They fly away to a plant or bush or tree at the water's edge, and there they cling for a little while and then cast their skin again."

"The new skin they have just got, with the wings and everything?" asks Mary.

"Exactly; the new skin. It comes off of the wings, off of the long tails and the short feelers, and all the rest of the body. No other kind of insect but the May-fly casts its skin once its wings are outspread. But now the May-fly is ready for its dizzy dance. And as it has only a few hours to do it in, it usually starts as soon as there

are any lights to dance about. Think of it, to come up from under the water, get your wings and be a real May-fly, not just a crawling thing on the bottom of a pond, and have only one evening to live in! Probably to dance the whole evening through is about the best thing to do under such circumstances."

"Don't any of the poor May-flies live for more than one evening?" asks Mary. "It does seem a shame to put in so long a time, one year, two years for some, getting ready to fly and then have only one evening or night for flying."

"Well, yes, some do, Mary. That is, there are many different kinds of May-flies; some large ones, some small ones, some kinds with four wings, some kinds with only two, and the length of the flying time is not the same for all these kinds. Some live a day, some two, some perhaps even three or four. But there are several kinds whose flying life is just a few

hours; they are born, that is, as flying creatures, after sundown and they die before the next sunrise. The first kind of May-fly whose life was ever carefully studied—this was nearly two hundred and fifty years ago, by a famous naturalist of Holland—lives only five hours after it comes from the water. But remember what a fine long time they have being young! If we could be young—but there, that's foolish. Mary, the chimes in the tower-clock are sounding. Listen!"

And we sit perfectly still and hear the beautiful Haydn changes on the four bells, and then count twelve clear strokes of the big clock-bell that come all the way from the Quadrangle to us, softened and mellowed by the distance. We must go home to luncheon. And after luncheon I must go and lecture—Ugh! How sad!—sad for the students and sad for me. But that's the way we do it, and until we find the real way, we must all continue to suffer together.

"Come, Mary, we're off. How would you like to be a May-fly?"

"And have only one day to live when I'm all grown up?"

"You might be saved some troubles, Mary."

IN·FVZZY'S·GLASS·HOVSE

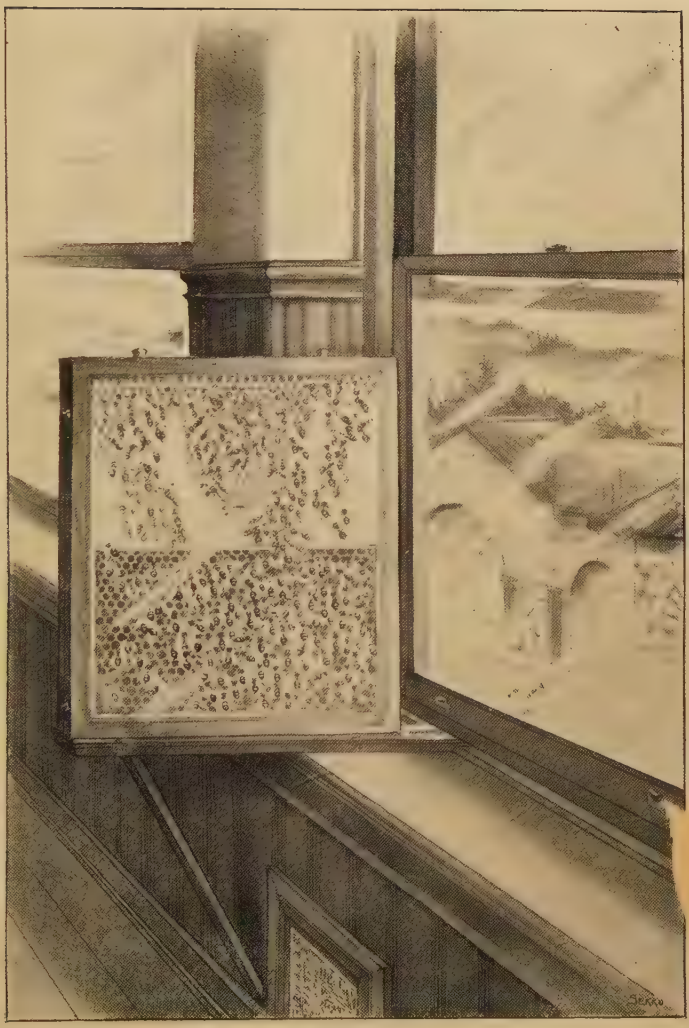
IN FUZZY'S GLASS HOUSE

Fuzzy was distinguished from most of her brothers and sisters, when we first became acquainted with her, by the fine head of hair which she had. It has been several weeks now since we first saw her, and there are bald places already—so strenuous has been her life. To be sure that we should be able to recognize her even after she became worn and bald, like the others, we dabbed a spot of white paint on her back between the shoulders, and although old age and its attendant ills, including the loss of much of her hair, have come on rapidly, the white spot is still there, and we know Fuzzy whenever we see her.

We were watching what was going on in Fuzzy's glass house at the very time that

Fuzzy first came out of her six-sided little private nursery room. In this she had spent all of her three weeks of getting hatched from an egg—we had seen her own very egg laid by the queen mother! —then of living as a helpless baby bee without wings or feet or eyes or feelers, and having to be fed bee-jelly and bee-bread by the nurses, and then as a slowly maturing young bee with legs and wings and eyes and feelers all forming and growing. Part of this time she had been shut up in her room by having the door sealed with wax, and she had had no food at all. But she had been fed enough at first to last her through the days when she had no food.

It was the twentieth or twenty-first day since she had been born, that is, had hatched from the little, long, white, seed-like egg that the queen bee had laid in this six-sided waxen room or cell. And Fuzzy was all ready to come out into the world.



So she tried her strong new trowel-like jaws on the thin waxen door of her room, and found no trouble at all in biting a hole through it large enough to let her wriggle out. Which she did right under our very eyes.

Indeed we had planned Fuzzy's glass house and had had it built in the way you see it in Sekko's picture just so we could see plainly and certainly what goes on in the house of a bee family. Everybody has watched bees outside gather pollen and drink nectar and hang in great swarms, and do the various other things they do in their outdoor life. But not everybody has seen what goes on indoors. Many people have seen the inside of a hive every now and then. But it is always when the bees are greatly excited and often when the people are too. And so besides seeing that the honey and pollen are in such and such combs and cells and the young bees in others, some of them in open and some

in closed cells, and perhaps a few other things, one doesn't learn much by peering into a hive through a mass of smoke-dazed bees while dodging a few extra-lively and energetic ones!

Mary and I had watched bees outside and we had looked into lots of hives and, of course, had learned a little about indoor bee ways. But ever since we got Fuzzy's glass-sided house built and a community of pretty amber-bodied gentle Italians living in it, we have never got over being sorry for ourselves in the old days and sorry for other people all the time. For it is so easy and sure, so vastly entertaining and utterly fascinating to sit quietly and comfortably in chairs (one of us on each side) for hours together and see all the many things that go on in the bee's house. The bees are not disturbed in the slightest by our having the black cloth jacket off of the hive and by the light shining in through the great window-like sides

of the house, nor by Mary's bright eyes and my round spectacles staring ever so hard at them.

We have seen the queen lay her eggs, the little bees hatch out, the nurse bees feed them, the foragers come in and dance their whirling dervish dance and unload their baskets of pollen and sacs of honey, the wax-makers hang in heavy festoons and make wax, the carrying bees carry the wax to the comb-builders, and the comb-builders build comb of it, the house-cleaners and the ventilators clean house and ventilate, and the guards stopping intruders at the door. We have heard the piping of the new queens in their big thimble-like cells, and seen them come out, and the terrible excitement and sometimes awful tragedy that follows; we have seen the wild ecstasy that comes before swarming out, and the swarming itself begin in the house; we have looked in at night and found some of the bees resting, but others working, and

always some on guard; we have seen the lazy drones loaf all the morning and then swing out on their midday flight and come back and fall to drinking honey again; we have seen a great battle when our gentle Italians fought like demons and repulsed a fierce attack of foraging black Germans, and again a nomad band of yellow-jackets; and we have seen the provident workers kill the drones and even drag young worker bees from their cells when the first cold weather comes on. We have seen, in truth, a very great deal of all the wonderful life that these wise and versatile little creatures live in their nearly perfect cooperative community. But above all we have followed with special interest and affectionate pride the education and experiences of Fuzzy, our most particular friend in all the thousands of our gentle Italian family.

Fuzzy must have been very glad to get out finally from her tight, dark, little cell

and into the airy, light hive, with all of her sisters and brothers moving around so lively and busily. And she must have been especially delighted when she went to the open door of the house for a peek out—for she wasn't allowed really to go outdoors for exactly eight days—and saw the beautiful arcades of the outer Quadrangle underneath her and the red-tiled roof on a level with her, and then the great eucalyptus trees and the beautiful live-oaks in the field beyond, and far off on the horizon the crest of the distant mountains, with the giant redwoods standing up against the sky-line. You have a glimpse in Sekko's picture of all this that Fuzzy saw that day. That is, if she could see so much. I am afraid she couldn't.

"But what are those other bees doing to her," cried Mary in some alarm, as two or three workers crowded around Fuzzy just as she came from her cell. "Are they trying to bite her?"

"Not the least in the world," I hasten to answer reassuringly. "Just look sharp and you will see." And Mary did look sharp and did see. And she clapped her hands with glee. "Why, they are licking her with their long tongues; cleaning her, just as a cat does her little kittens," sang Mary. Which was exactly so. For a bee just out from its nursery cell is a very mussed-up looking, and, I expect, rather dirty little creature. And it needs cleaning.

It was soon after Fuzzy had got cleaned and had her hair brushed and had begun to wander around in an aimless way in the glass-sided house that we got hold of her and dabbed the spot of white paint on her back. We did it this way. She had walked up to just under the roof of the house near where you see (in Sekko's picture) one of the cork-stoppers sticking up like a little chimney-pot. These corks stop up two round holes in the roof which

we had made for the express purpose of putting things,—other insects, say,—into the hive to see what the bees would do with them, and also to take out a bee when we wanted to experiment with it. When Fuzzy got up just under one of the holes, we took the cork-stopper out gently and thus let her come walking slowly up and out on top of the roof. Then we caught and held her very gently with a pair of flat-bladed tweezers, and put the white paint on. Then we dropped her back through the hole and put the cork in its hole.

We watched Fuzzy for a long time after she came out of her cell that day, and although she walked about a great deal, she only once ventured near the real door or entrance-slit of the hive through which the foraging bees were constantly coming and going. And next day we watched many hours and looked often between regular watching times, always finding

Fuzzy in the house. And so for eight days. And then she made her first excursion outside.

It was interesting to watch her on this eighth day. She would fly a little way out, then turn around and come in. Then she would fly out farther, turn around, hover a little in front of the window, and finally come in again. A lot of other young bees were doing the same thing. They seemed to be getting acquainted with things around the door of the house so they would know how to find it when they came back from a long trip. On the ninth day Fuzzy brought in her first loads of pollen, two great masses of dull rose-red pollen held securely in the pollen-baskets on her hind legs. And after that she brought many other loads of pollen and later sacs of honey.

But you must not imagine that Fuzzy was idle during all those eight days before she went outside of the glass house. Not

a bit of it. No bees are idle. But yes, the drones. Big, blunt-bodied, hairy, blundersome creatures that move slowly about over the combs. Not over the nursery combs where there is work to be done, feeding and caring for the young bees. Dear me, no. But over the pantry combs. They keep close to the honey-pots and bread-jars. But even they have their work. Each day from spring into late summer they all, or nearly all, fly out about eleven o'clock and circle and traverse the air for long distances in search of queens. Then in the early afternoon they come back and fall to sipping honey again.

However, to return to Fuzzy and her work in those first eight days spent all inside the house. One day Mary saw Fuzzy stretching her head down into one open cell after another in the brood-comb. At the bottom of each of these cells was a little white grub; a very young bee, of

course, only one or two or three or four days out from the egg. Several days before (it takes only three days for a bee's egg to hatch) we had seen the beautiful long slender-bodied queen moving slowly about over these cells, with her little circle of attendants all moving with her with their heads always facing toward her. She would thrust her long hind body down into one of these empty cells and stand there quietly for two or three minutes. Then draw her body out and go on to another. And in the cell she had just left we could see plainly a tiny seed-like white speck stuck to the bottom of the cell. It was an egg of course. That is nearly all the queen does; she simply goes about all through the spring and summer laying eggs, one at a time, in the nursery or brood-cells. There is one other thing she does, or really several things, at the time of the appearance or the birth of a new queen. But that will come later.

We do seem to have trouble keeping to Fuzzy and her life, don't we? Well, when Mary saw Fuzzy sticking her head down into the cells with the bee-grubs in, she knew at once what Fuzzy was doing. For it was plain that the young bees had to have something to eat and it was plain, too, that they couldn't get it for themselves, for they have no legs, and can't even crawl out of their cells. Fuzzy was feeding them. She would drink a lot of honey from a honey-cell, and eat a lot of pollen from a pollen-filled cell, and then make in her mouth or front stomach (for bees have two stomachs, one in front of the other), or in certain glands in her head (it doesn't seem to be exactly known which), a very rich sort of food called bee-jelly. Then she sticks the tip of her long tongue into the mouth of the helpless, soft-bodied little white bee-grub and pours the food into it. After the bee-grub is two or three days old, the nurse bees—

and that is what Fuzzy could be called now—feed the babies some honey and pollen in addition to this made-up bee-jelly, unless the baby is to be a queen bee, and then it gets only the rich bee-jelly all the time.

Mary thought Fuzzy should have a neat cap and white apron on and drew a clever little picture of Fuzzy as a nurse. But we are being very careful in this book not to fool anybody, and if we should print the picture Mary drew, some people would be stupid enough to think that we meant them to believe that the nurse bees wear uniforms! We say right now that they don't, and that you can't tell them from the other bees except that most of them are the younger or newly issued bees and hence haven't lost any of their hair, and so look "fuzzier" than the other bees in the hive. For just as with Fuzzy, so with the other younger bees; they stay in the hive for a week or more and act as nurses.

When they once are allowed to go out, and begin bringing in pollen and honey, however, then the new bees are ready to do any of the many other things that have to be done inside the hive. One day Mary saw Fuzzy standing quite still on the floor of the house, with her head pointed away from the door and held rather low, while her body was tilted up at an angle. She just stood there immovable and apparently doing nothing at all. Suddenly Mary called out: "Why, what has happened to Fuzzy? Her wings are gone!" I hurried to look. And it did seem, for a minute, as if Mary were right. Which would have been a most surprising and also a most terrible thing. But my eyes seemed to see a sort of blur or haze just over Fuzzy's back, and I bade Mary look close at this blur with her sharp eyes. And Mary solved the mystery.

"She is fanning her wings so fast that you can't see them," cried Mary. "And

here is another bee about two inches in front of Fuzzy doing the same thing; and another," called out Mary, who was greatly excited. And it rather did seem as if these bees had gone crazy, or were having a very strange game, or something. Until I made Mary remember what would happen to us if not just three or four or five or six of us, but many thousand—indeed in Fuzzy's house there are more than ten thousand—were shut up in one house with but a single small opening to let fresh air in and bad air out. For bees breathe just as we do, that is, take fresh air into their bodies and give out poisonous air. And then Mary understood. Fuzzy and the other bees fanning their wings so fast and steadily were ventilating the house! They were making air-currents that would carry the poisonous air, laden with carbonic-acid gas, out of the door, and then fresh air would come in to replace it.

And another time Fuzzy kept Mary

guessing a little while about what she was doing. We had looked all through the crowds of nurses and wax-makers and comb-builders and house-cleaners without finding Fuzzy. And we decided she was out on a foraging trip, when Mary caught sight of our white-spotted chum loafing about in the little glass-covered runway that leads from the outer opening into the house proper, a sort of little glass-roofed entry we have arranged so that we can see the foragers as they alight and come in, and the various other things that go on by the door. Fuzzy seemed to be loafing, but both Mary and I have seen so much of the feverish activity and the constant work of bees in the hive, and out of it for that matter, that we never expect to find a worker honey-bee really loafing. They literally work themselves to death, dying sometimes at the very door of the hive, with the heavy baskets of pollen on their thighs, the gathering and carrying of which has

been the killing of them. Only the bees that over-winter in the hive must have some spare moments on their hands. And here in California even these are few, for a certain amount of foraging goes on practically all the year round.

But Fuzzy did seem to be loafing there in the entry. Until Mary's sharp eyes discovered her important business. She was one of the warders at the gate, a guard or sentinel told off, with one or two others, to test each arrival at the entrance. As a forager would alight and start to walk in through the entry, Fuzzy would trot up to it and feel it with her sensitive antennæ. If the newcomer were a member of the community, all right; it was passed in. But if not,—if it were one of the vicious black Germans from the other observation hive that stands close by, opening out of the same window indeed,—there would be an instant alarm and a quick attack. Two or three Italians would pounce on the in-

truder, who would either hurry away or, if bold enough to fight, would get stung to death and pitched unceremoniously out of the entry. Or if it were a stray yellow-jacket attracted by the alluring odor of honey from the hive, one of the same things would happen. One day not a single German came, but an army, a guerrilla band intent on pillage and murder. And then there was a grand battle—but we must wait a minute for that.

There were also other enemies of Fuzzy's glass house besides German bees and yellow wasps. There is a delicate little moth, bee-moth it is called, that slips into the hive at night all noiselessly and without betraying its presence to any of the bees if it can help it. And it lays, very quickly indeed, a lot of tiny round eggs in a crack somewhere. It doesn't seem to try to get out. At any rate it rarely does get out. For it almost always gets found out and stung to death and pulled and

torn into small pieces by the enraged bees, who seem to go almost frantic whenever they discover one of these innocent-seeming little gray-and-brown moths in the house. And well they may, for death and destruction of the community follow in the train of the bee-moth. From the eggs hatch little sixteen-footed grubs that keep well hidden in the cracks, only venturing out to feed on the wax of the comb nearest them. As they grow they need more and more wax, but they protect themselves while getting it by spinning a silken web which prevents the bees from getting at them. Wherever they go they spin silken lines and little webs until, if several bee-moths have managed to lay their eggs in the hive and several hundred of their voracious wax-eating grubs are spinning tough silken lines and webs through all the corridors and rooms of the bees' house, the household duties get so difficult to carry on that the bee community begins

to dwindle; the unfed young die in their cells, the indoor workers starve, and the breakdown of the whole hive occurs. Such a thing happened in this very glass house of Fuzzy's a year before we got acquainted with Fuzzy herself. And we had to get a new family of bees to come and live in the house after we had cleaned out and washed and sterilized all the cracks and corners so that no live eggs of the terrible bee-moth remained.

Some days we found Fuzzy at work with several companions on more prosaic and commonplace things about the house; chores they might be called. She had to help clean house occasionally. For the bees are extremely cleanly housekeepers, with a keen eye for all fallen bits of wax, or bodies of dead bees, or any kind of dirt that might come from the housekeeping of so large a family. Every day the hive is thoroughly cleaned. If there comes a day when it is not, that is a bad sign. There

is something wrong with the bee community. They haven't enough food, or they are getting sick, or something else irregular and distressing is happening.

Also the house has to be "calked" occasionally to keep out draughts and more particularly creeping enemies of the hive, like bee-moths and bee-lice. The cracks are pasted over with propolis, which is made from resin or gum brought in from certain trees. If something gets into the hive that can't be carried out, then the bees cover it up with propolis. If they find a bee-moth grub in a crack where they can't get to it to sting it to death, they wall it up, a living prisoner, with propolis. Once our bees kept coming in with a curious new kind of propolis; a greenish oily-looking stuff that stuck to their legs and got on their faces and bodies and wouldn't clean off. We discovered that they were trying to unpaint a near-by house as fast as it was being freshly painted!

Fuzzy took her turn at all these odd jobs, and though she was beginning to show here and there a few places where her luxuriant hair was rubbed off a little, she was still as lively and willing and industrious as ever. Every day we liked her more and more and wished, how many times, that we could talk with her and tell her how much we liked her, and have her tell us how she enjoyed life in the glass house. But we could only watch her and keep acquainted with all her manifold duties and hope that nothing would happen to her on her long foraging trips for pollen and nectar and propolis. Whenever Mary and I came to the glass house and couldn't find Fuzzy, we were in a sort of fever of excitement and apprehension until she came in with her great loads of white or yellow or red pollen and went to shaking and dancing and whirling about in the extraordinary way that she and her mates have while hunting for a suitable

pantry cell in which to unload ner pollen-baskets. Sometimes she would walk and dance and whirl over almost all of the pollen-cells in the house before she would finally decide on one. Then she would stand over it and pry with the strong sharp spines on her middle legs at the solidly packed pollen loads on her hind legs, trying to loosen them so they would fall into the cell. Sometimes she simply couldn't get the pollen loads loose, and then a companion would help her. And after they were loosened and had fallen into the cell, she or a companion would ram her head down into the cell and pack and tamp the soft sticky pollen loads down into one even mass. And then how industriously she would clean herself, drawing her antennæ through the neat little antennæ combs on her front legs, and licking herself with her long flexible tongue, or getting licked by her mates all over.

Perhaps as she was washing herself after

a hard foraging trip, the stately and graceful queen of the house would come walking slowly by, looking for empty cells in which to lay eggs. Then Fuzzy would turn around, head toward the queen, and form part of the little circle of honor that always kept forming and re-forming around the queen mother. For the honey-bee queen is the mother of all the great family, and her relation to the community is really the mother relation rather than that of a reigning queen. She does not order the bees; indeed, the worker bees seem to order her. They determine what cells she may have to lay eggs in and when she shall be superseded by a new queen. And when they decide for a new queen, they immediately set to work in a very interesting way to make one.

This is the way, as Mary and I saw it through the glass sides of Fuzzy's house. First, a little group of workers went to work tearing down, apparently, some comb

already made; that is, they began on the lower edge of a brood-comb, in the cells of which the old queen had just laid eggs, to tear out the partitions between two or three of the cells. What became of the eggs we couldn't tell, for they are very small, and the bees were so crowded together that we could see only the general results of their activity. Soon it was evident that they were building as well as tearing down, and a new cell, much larger than the usual kind and quite different in shape, began to take form. It was like a thimble, only longer and slenderer, and it had the wide end closed and the narrower tapering end open. They worked excitedly and rapidly, and the new cell steadily grew in length. Never was it left alone for a minute. Always there were bees coming and going and always some clustered about. It was a constant center of interest and excitement.

Mary and I knew of course that this was

a queen cell, and that at its base there was one of the eggs laid by the old queen in a worker cell. This egg hatched, we knew, in a few days, although we could not see the little grub, but nurse bees were about constantly besides the cell-builders, and all the bees that came to the wonderful new cell seemed to realize that a very important, if at present rather grubby and wholly helpless, personage was in it. The cell finally got to be more than an inch long, and at the end of five days it was capped. A lot of milky bee-jelly had been stored in it before capping. After this nothing happened for seven days.

Mary was in the room where the glass bee-houses are, and I was in an adjoining room, with the door between the two open. As I sat peering through my big microscope, I seemed to hear a curious unusual sound from the bee-room, a sort of piping rather high-pitched but muffled. Perhaps it was Mary trying a new song.

She has a good assortment of noises. But now came another sound; lower-pitched but louder than the other; a trumpet-call, only of course not as loud as the soldiers' trumpets or the ones on the stage when the King is about to come in. Then the shrill piping again; and again the trumpet answer. And finally a third and new sound, but this last unmistakably a Mary sound. And with it came the dear girl herself, with her hair standing on—well, no, I cannot truthfully say standing on end, but trying to. And her eyes shooting sparks and her mouth open and her hands up.

"The bees," she gasped, "the bees are doing it!"

There was no doubt of what "it" meant. It was this sounding of pipes and trumpets; these battle calls.

I leaped to my feet; that is, if an elderly professor, who has certain twinges in his joints occasionally, can really leap. Anyway I knocked over my chair—and pre-

cious near my microscope—in getting up, and started for the bees. And that shows the high degree of my excitement. But never before in all the years I had played with bees had I heard the trumpet challenges of queen bees to the death duel. Inside the cell was the new queen shut up in darkness, but ready and eager to come out, and piping her challenge. And outside, brave and fearless, if old and worn, was the mother queen trumpeting back her defiance. It was the spirit of the Amazons.

And *what* excitement in the hive! Simply frantic were the thousands of workers. We watched them racing about wildly; up, down, across, back; but mostly clustering in the bottom near the queen cell. And working industriously at the cell itself, a a group of builders, strengthening and thickening the cell's walls especially at the closed lower end. They seemed to be, yes, they were, preventing the new queen inside from coming out. She was probably

gnawing away with her trowel-like jaws at the soft wax from the inside, while they were putting on more wax and keeping her a prisoner.

This went on for two or three days. The piping and trumpeting kept up intermittently, and the thickening of the cell constantly. Until the time came!

And now I am going to disappoint you dreadfully. But much less than Mary and I were disappointed. We were not there when the time came!

The bees were excited, I have said. Mary and I were excited, I have said. The bees put in *all* their time being excited and watching the queen cell. We put in *most* of ours. But we had to eat and we had to sleep. The bees didn't seem to. And so we missed the coming out. What a pity! How unfair to us! And to you.

As there is by immemorial honey-bee tradition but one queen in a community at one time, when new queens issue from

the great cells, something has to happen. This may be one of three things: either the old and new queens battle to death, and it is believed that in such battles only does a queen bee ever use her sting, or the workers interfere and kill either the old or new queen by "balling" her (gathering in a tight suffocating mass about her), or either the old (usually old) or new queen leaves the hive with a swarm, and a new community is founded. In Fuzzy's community this last thing happened when the new queen came out.

Mary and I were on hand very early the morning of the third day after the piping and trumpeting had begun. As we jerked the black cloth jacket off the hive to see how things were, we were astonished at the new excitement that was apparent in the hive; the bees seemed to be in a perfect frenzy and had suspended all other operations except racing about in apparent utter dementia. We could find neither

the old queen nor the new queen in the seething mass, nor could we even see whether the queen cell was open or still sealed up.

Another curious thing was that the taking off of the black cloth jacket seemed to affect the bees very strongly. They had suddenly become very sensitive to light, and while, when the jacket was on, they all seemed to be making towards the bottom and especially towards the exit corner, which was the lower corner next to the window, as soon as we lifted off the jacket they seemed all to rush up to the top where the light was strongest. So nearly simultaneous and uniform were the turning and rushing up that the whole mass of bees seemed to flow like some thick mottled liquid.

It was evident that all this was the excitement and frenzy of swarming. And it was also evident that the bees, in their great excitement, were finding their way

to the outlet by the light that came in through it. And when we removed the cloth jacket we confused them because the light now came into the hive from both sides and was especially strong at the top, which was nearest the greatest expanse of the outer window. So we finally let the jacket stay on, and after a considerable time of violent exertion, the bees began to issue pell-mell from the door of the house. The first comers waited for the others, and there was pretty soon formed a great mass of excited bees around the doorway, and clustered on the stone window-sill just outside. Then suddenly the whole mass took wing and flew away together. And pretty soon all was quiet in the hive.

Mary and I had been nearly as excited as the bees, and we were glad to sit and rest a little and get breath again. Soon it was luncheon time and we went off to Mary's house without looking into the hive. We had had just about all the bee

observing we needed for one forenoon. But almost the first thing that Mary did at the table was to straighten up suddenly and cry out, "I wonder if Fuzzy swarmed!" And thereafter that was all we thought of, and we made a very hasty meal of it. And the moment we got up we hurried back to Fuzzy's home and jerked off the black jacket.

How quiet everything was inside. And how lessened the number of bees. Fully one-third of the community must have gone out. We set to work looking carefully at all the remaining bees. It was only a minute or two before Mary clapped her hands and cried, "She's here!" "She" was Fuzzy, of course. And we were both very glad that Fuzzy had not deserted the glass house—and us.

Some one came in and said that a "lot of your bees are out here hanging on to a bush." But we had seen "swarms" before, and were much more interested

in finding out what the bees do inside after a swarm has gone off than in watching the swarm outside. We knew that "scouts" would fly away soon from the great hanging bunch or swarm to look for a suitable new home; a hollow tree, a deserted hive, a box in hedge corner, any place protected and dark, and when they had found one, they would come back, and soon the whole swarm would fly off to the new house. Once one of our swarms started down a chimney of a neighbor's house, and immensely surprised the good people by coming out, with a great buzzing, into the fireplace! And another swarm, not finding a suitable indoors place, simply began to build new combs hanging down from the branch of a cypress-tree in the Arboretum, and really made an outdoor home there, carrying on all the work of a bee-community for months. But usually a bee-swarm gets found by some bee-keeper and put into an empty hive.

And that is what happened to our deserters.

After Mary had found Fuzzy, who seemed to have lost considerable hair and to have got pretty well rubbed in the grand melée, she continued to peer carefully through the glass side of the hive. And I looked carefully too. Of course we wanted to find out about the queens. Was there any queen left in our hive? We knew there must be a queen with the swarm; bees don't go off without a queen. So if the old and new queen had fought and one had been killed, or if the workers had "balled" the new queen when she came out, there could be no queen left in the hive. Of course this would not be very serious. For there were many eggs and also many just-hatched bee-grubs in the brood-combs, and the workers could easily make a new queen. But this wasn't necessary, for we soon found a graceful, slender-bodied bee, but so fresh and brightly colored and clean

that we knew her to be the new queen and not the old.

Things were perfectly normal and quiet. Some foragers were coming and going; house-cleaners were busily at work on the floor of the house, and nurses were moving about over the brood-cells. Not a trace of the wild frenzy of the forenoon. What a puzzling thing it is to see all the signs of tremendous mental excitement in other animals and yet not to be able to understand in the least their real condition! They may seem to do things for reasons and impulses that lead us to do things, but we can't be at all sure that their mental or nervous processes, their impulses and stimuli, are those which control us. We can't possibly put ourselves in their places. For we are made differently. And therefore it is plainly foolish to try to interpret the behavior of the lower animals on a basis of our understanding of our own behavior. Insects may see colors we can-

not see; may hear sounds we cannot hear; smell odors too delicate for us to smell. In fact, from our observations and experiments, we are sure they do all these things. The world to them, then, is different from the world to us. And their behavior is based on their appreciation by their senses in their own way of this different world.

What determines which queen shall leave the hive with the swarm? What determines which five thousand out of fifteen thousand worker bees, all apparently similarly stimulated and excited, shall swarm out, and which ten thousand shall stay in? These are questions too hard for us to answer. We may take refuge in Maeterlinck's poetical conception of the "spirit of the hive." Let us say that the "spirit of the hive" decides these things. As well as what workers shall forage and what ones clean house; what bees shall ventilate and what make wax and build comb.

Which is simply to say that we don't know what decides all these things.

The reduction in numbers of the inmates of Fuzzy's house made it much easier to follow closely the behavior of any one bee, or any special group of bees doing some one thing. And both Mary and I had long wanted to see as clearly as possible just what goes on when the bees are making wax and building comb. We had often examined, on the bodies of dead bees, the four pairs of five-sided wax-plates on the under side of the hind body. We knew that the wax comes out of skin-glands under these plates as a liquid, and oozes through the pores of the plates, spreading out and hardening in thin sheets on the outside of the plates. To produce the wax certain workers eat a large amount of honey, and then mass together in a curtain or festoon hanging down from the ceiling of the hive or frame. Here they increase the temperature of their bodies

by some strong internal exertion; and after several hours or sometimes two or three days, the fine glistening wax-sheets appear on the wax-plates. These sheets get larger and larger until they project beyond the edges of the body, when they either fall off or are plucked off by other workers.

It was only two or three days after the excitement of the swarming out that Mary and I saw one of these curtains or hanging festoons of bees making wax, and you may be sure we tried to watch it closely. The bees hung to each other by their legs and kept quite still. The curtain hung down fully six inches from the ceiling of the house, and the first or upper row of bees had therefore to sustain the hanging weight of all those below. And there were certainly several hundred bees in the curtain. The wax-scales began to appear on the second day. And many of them fell off and down to the floor of the house. Some of the scales were plucked off by

other workers and carried in their mouths to where a new comb had been started before the swarming, and either used by themselves to help in the comb-building or given to comb-builders already at work. Some of the scales were plucked off by the wax-making workers themselves, who then left the curtain and carried the wax-scales to the seat of the comb-building operations. Various other workers picked up from the floor the fallen scales and carried them to the comb-builders. These building bees would chew up pieces of wax in their mouths, mixing it with saliva, and then would press and mould it with their little trowel-like jaws against the comb, so as to build up steadily the familiar six-sided cells.

Each layer of comb is composed of a double tier or layer of these cells, a common partition or base serving as bottom of each tier. The cells to be used for brood are of two sizes, smaller ones for workers

to be reared in, and larger ones for the drones. Sometimes the queen lays drone eggs in worker cells and then the cells have to be built up higher when the drone-grub gets too large for its cell. Sometimes, too, the worker bees lay eggs—this happens often in a hive bereft by some accident of its queen—but these eggs can only hatch into drones. Occasionally the workers make a mistake and build a queen cell around a drone egg. This happened once in our hive when there were no queen-laid eggs in the brood-cells, and some workers had laid eggs. The workers tried to make a new queen out of one of these eggs, but of course only a worthless drone came out of the queen cell. In building comb and cells for storing honey, new wax is almost exclusively used, but for brood-comb old wax and wax mixed with pollen may be used. Any comb or part of a comb not needed may be torn down and the wax used to build new comb or to cap cells with.

I have said that the nearest neighbors of Fuzzy's family are a lot of black German bees, housed in a larger house than Fuzzy's, but one also with glass sides so that we can see what goes on inside. The door of the house opens through the same large window as that of Fuzzy's house, but the foragers coming back from their long trips rarely make a mistake in the doors, the Germans coming to their door and the Italians to theirs. The German community is much the larger, there being probably thirty or forty thousand workers in it, although of course only one queen, and only a few hundred drones. Sometimes the foragers, both Germans and Italians, make the mistake of coming to the wrong window of the room in which their houses are. There are five large windows all alike in the west wall of this room, and often we find our bees bumping against the other windows, especially the ones just next to the right one. They can't, of

course, see in through these windows because the room is much darker than outside, and so all that the home-coming bees can see as they approach the building is a row of similar windows separated from each other by similar spaces of buffy stone. And keen as our bees are in finding their way straight to their hives from distant flower-fields, this repetition of similar windows seems to confuse some of them.

But what I started to tell about is something that happened between the neighboring bee-houses quite different from the troubles of the bees finding their way home. It was something that gave Mary and me the principal excitement that we had in all our many days of watching bees.

Mary and I do not want to say that the German bees knew that a third of Fuzzy's community had swarmed out and gone away. Though how they could help knowing it really seems more a puzzle, for there

was excitement and buzzing and window-sill covered and air full of bees enough to have told everybody within a rod of what was going on in the Italian house. But it was true that Fuzzy's community had never been troubled at all seriously by the belligerent Germans, until after it had been much reduced in strength by the loss of one-third of its members. And then this trouble did come, and came soon. So it looks as if the Germans realized the weakness of their neighbors. But perhaps not.

Just as our other exciting time beginning with the piping of the new queen and lasting until the subsequent swarming was a discovery of Mary's, so with this new time of high excitement; high excitement I may say both on our part and the bees'. Mary was in the room where the bees are, although not at the moment watching them, when she heard a sound of violent buzzing and humming. It grew quickly

louder and shriller, and in a moment both communities were in an uproar.

It was a battle, a great battle. On the one hand, a struggle by brutal invaders intent on sacking the home and pillaging the stores of a community given to ways of peace and just now reduced in numbers by a migration or exodus from home of a large group of restless spirits; on the other hand, a struggle for home and property and the lives of hundreds of babies by this weak and presumably timid and unwarlike people. A great band of Germans were at the door of Fuzzy's house trying to get in! They buzzed and pushed and ran their stings in and out of their bodies, and crowded the entryway full. But the Italian workers and guards had roused their community, and pouring out from the hive into the narrow entry was a stream of angry and brave amber bees, ready to fight to the death for their home.

It was really a terrific struggle. The

Italians, few in numbers as a community, were yet enough to oppose on fairly equal terms the band of Germans, for by no means all the Germans had come from their house. And the Italians had the great advantage of being defenders. They had only to keep out the black column trying to force its way in through the narrow door and entry. And they were no laggards in battle. They fought with perfect courage and great energy. Often a small group of Italians would force its way out of the door and into the very midst of the Germans outside on the window-sill. These brave bees were all killed, overwhelmed by the superior numbers of the enemy. But not until they had left many dying Germans on the stone window-ledge were their own paralyzed and dying bodies hustled out of the way.

In many cases the combat took on the character of duels between single pairs of combatants. A German and an Italian

would clasp each other with jaws and legs, and thus interlocked and whirling over and over with violent beating of their wings would stab at each other until one or both were mortally wounded. All the time the frenzied ball would be rolling nearer and nearer the outer edge of the treacherous sloping window-ledge, until finally over it would go, whirling in the air through the thirty feet of fall to the ground below. Here the struggle would go on, if the fighters were not too stunned by the fall, until one or both bees were dead or paralyzed.

It is really too painful to tell of this fight. And it was painful to watch. But the end came soon. And it was a glorious victory for Fuzzy and her companions. The German robbers flew back, what were left of them, to their own hive. Mary and I tried all through the fight to watch Fuzzy. But we saw her only once; she was in the entry then and nearly in the front row of

fighters. We were glad to see her so brave, but fearful for her fate. After the fight we looked anxiously through the hive for our little white-spotted friend. We didn't see her, and were ready to mourn her for lost, when Mary happened to look out on the window-ledge where a few Italians were pushing the remaining paralyzed or dead Germans off. There was Fuzzy dragging, with much effort, a dead, black bee along the rough stone.

We were very happy, then, and wanted more than ever to be able to talk to our brave little champion and rejoice with her over the splendid victory. But we could only do as Fuzzy seemed to be doing. That is, take up again the work that lay at our hands. My work was to go into the lecture-room and talk to a class about the absence of intelligence and mind and spirit in the lower animals and the dependence of their behavior upon physics and chemistry and mechanics! Mary's

work was to go out into the poppy-field and talk with the little grass people whom she never sees or hears, but knows are there.

THE·ANIMATED·HONEY=JARS·

ANIMATED HONEY-JARS

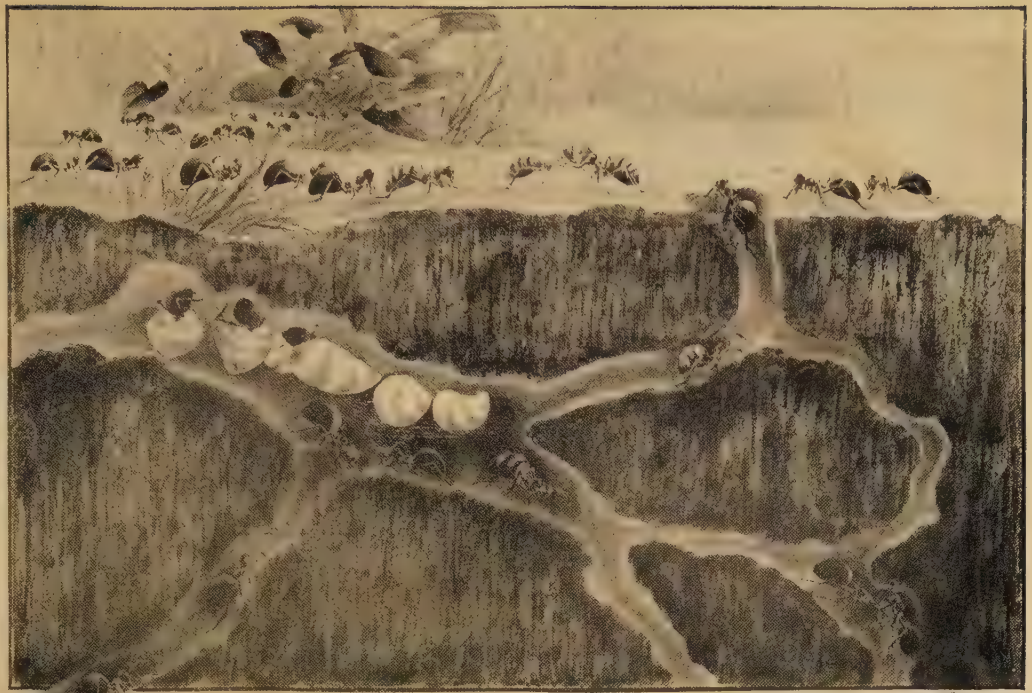
It was one evening not long after our afternoon on Bungalow Hill, where Mary had found the mealy-bugs in the runways of an ant's nest under a stone, and I had told her about the clever little brown ants and their aphid cattle in the Illinois corn-fields. Ever since that afternoon Mary had been asking questions about ants, and so this evening I was translating bits to her from a new German book about ants. It told about the cruel forays of the hordes of the great fighting and robbing Ecitons of the Amazons; of the extraordinary mutually helpful relations between the Aztec ants and the Imbauba tree of South America, which result in the ants getting a comfortable home and special food from

only in Mexico and New Mexico and Colorado," says Mary. "Didn't the book say that?"

"Yes, that kind; but we have a kind of our own here in California. The sort that McCook found in the Garden of the Gods and studied all that summer twenty-five years ago is found only there and in the Southwest; but there are two or three other kinds of honey-ants known, and one of them that has never been told about in the books at all is right here on the campus. There are several of the nests here, or were a few years ago, and we'll go tomorrow and try to find one. It will be fine, won't it?"

"Fine," said Mary. "Good-night."

And so the next morning we went. The Arboretum is a place where once were planted almost all the kinds of trees that grow wild in California, besides many other kinds from Australia and Japan and New Zealand and Peru and Chili and several of



lilac, and the poison-oak is our autumn-red sumac.

At the foot of the Monterey pine we began our search for the honey-ants. We didn't, of course, expect to find them walking about with their swollen bodies full of amber honey, for the honey-bearers are supposed not to walk around, but to stay inside the nest, in a special chamber made for them. We looked rather for the honey-gatherers, the worker foragers.

Pretty soon Mary found a swift little black ant. But, no, it was an *Aphænogaster* that—

"A feeno-gasser?" asks Mary. "What is that?"

"That has the curious, flat-bodied dwarf crickets living with it in its nests," I continue. "*Myrmecophila*, the ant-lover, they call this little cricket which has lost its wings and its voice and is altogether an insignificant and meek little guest unbidden but tolerated at the ant's table. And here,

here is a big black-and-brown carpenter-ant going home with a seed in its mouth."

"Where is its home? Does it build a house out of wood? Let's follow it," Mary bursts in.

"No, we are after honey-ants, remember. We mustn't let ourselves get distracted by all these others. The carpenter-ants do make themselves a home of wood, but they do it by gnawing out galleries and chambers in a dead tree trunk or stump or in a neglected timber. That isn't exactly building, but it is at least a kind of carpentering, a sort of—"

"Is this one?" interrupts Mary, poking violently at an angry red-headed little slave-maker ant that seemed anxious to get off to its home where its slaves, which are other ants captured when still young and unacquainted with their rightful family, do all the work of food-getting and cleaning and taking care of the babies.

And then I recognized a *Prenolepis*, that

is,—and I *do* beg pardon,—one of our campus honey-ants. Of course I suppose they are elsewhere in California and perhaps north in Oregon and east in Nevada and Arizona, but I have only seen them here, and hence always think of them as belonging exclusively with us campus-dwellers. It was a little brown ant with black hind body and paler under side. It isn't particularly impressive, for it is only about one-eighth of an inch long, and its colors and appearance are much like those of many other ants, but there is something about it sufficiently distinctive to let one recognize it at sight.

The thing to do now, of course, was to find its nest. There are various ways of finding the nest of any particular ant you may happen to discover running about loose over the country, but not one of them am I going to tell you. They are good things to work out for yourself. Mary and I know how, and so we had little trouble

and didn't have to spend much time in finding the home of our wandering *Prenolepis*,—there it is again,—campus honey-ant I mean. And that is a fair name for it, for McCook who found the famous honey-ants of the Garden of the Gods in Colorado named his kind *Myrmecocystus melliger hortusdeorum*, which is straight Latin and Greek for the "honey-pot ant of the Garden of the Gods." But *what* a name for a little ant one-eighth of an inch long to carry!

It would take too many words and I am afraid would be too trivial a story for even this very happy-go-lucky little book to tell how Mary and I dug and dug in the ground near the foot of the tree, and how carefully we worked with our garden-trowel and mostly with our fingers! And how we traced out runway after runway and opened chamber after chamber of the honey-ant's nest until we found the honey-pantry with its strange jars of sweetness

all hanging from the roof. The picture that Mary carefully sketched in, and that Sekko Shimada painted for us with his dainty Japanese brushes and little saucers of costly Japanese ink, shows very well part of the nest, that part that had one of the honey-rooms in. You won't see the base of the Monterey pine-tree in the picture, nor any of the other trees that were all around, because Mary didn't put them into her sketch, and we forgot to tell Sekko where the nest was. But the galleries and honey-chamber and the ants themselves are all right in Sekko's picture.

In some of the galleries we had found ants with considerably swollen hind bodies, which evidently had the stomach or crop well filled with some nearly transparent, pale yellowish-brown liquid. But it was not until we discovered the honey-pantry that we saw the extraordinary fully laden real live honey-jars, which were, of course, nothing but some of the worker ants hang-

ing by their feet from the roof of the chamber, with their hind bodies enormously swollen by the great quantity of honey held in the crop. In opening the chamber we dislodged two or three of the honey-jars that fell to the floor and could hardly turn over or walk at all, so helpless were they. And one of them broke and the honey came out in a big drop, and I tasted it on the tip of my little finger, and it was sweet. So it was surely honey. And you should have seen how eagerly two or three other workers in the chamber, without swollen bodies, lapped up this sweet drop that came out of the body of the poor, broken honey-jar!

As we had broken into the home of the honey-ants and had pretty nearly wrecked it, it seemed only fair that we should try to help our honey-ants begin another home under as kindly conditions as possible. So we put as many of them as we could find, foraging workers, honey-holders, and the

queen whom we found in a special queen room, into our glass fruit-jar with some soil, and brought them all home and put them into a formicary. Which is simply an artificial ants' nest, or house already arranged for ants to live in. It has a place to hold food and has dark rooms and sunny rooms, cool rooms and warm ones, all nicely fixed with runways connecting them, and food is put in as often as necessary and always in one place, which the ants learn to know very soon, indeed. This makes housekeeping easy and pleasant for the ants, and lets us see a great deal of how it is carried on, because there are glass sides and top to the house, so that by lifting little pieces of black cardboard or cloth we can look in and watch the ants at work.

The honey-ants' colony seemed to live very contentedly in our formicary, for they went ahead with all their usual business of laying eggs and rearing babies and feeding them, and finding honey and getting the

honey-jars loaded with it and hung by their feet from the ceiling of their room, and all the other things that go on regularly in a honey-ant's house.

The principal thing we wanted to do, however, was to learn how the honey-jars got filled and also how they got emptied again! And this was not at all hard to find out, although we never found out certainly where the worker foragers got their honey in the Arboretum. McCook found that his foragers in the Garden of the Gods gathered a sweet honey-dew liquid that oozed out in little drops from certain live oak-galls near the nest. But our ants seemed to be getting their honey from somewhere up in the pine-tree, for there was a constant stream of them going up and down the trunk. Besides, many of those coming down had swollen bodies partially filled with honey, while none of those going up did. Now the only honey supply in the pine-tree that we know is the honey-

dew given off liberally by a brown roundish scale insect that lives on the pine-needles. So we *think* our honey-ants gathered their honey material from these honey-dew scale insects. But we have seen them collect honey stuff from various aphids and also from the growing twigs of live-oak trees. They seem to be willing to take it wherever they can find it.

Of course we had to provide a supply of honey for our indoor colony, and this supply was eagerly and constantly visited by the foraging workers. They would lap it up and then go into the nest and feed the live honey-pots! That is, a well-fed forager would go into the honey-pantry and force the honey out from its own crop through its mouth into the mouth of one of the live honey-jars. Undoubtedly the honey-bee honey we furnished them was considerably changed while in the body of the foraging worker.

But all the time the nurses and workers

inside the nest needed honey for food. And this they got by going to the honey-pantry, and by some gentle means inducing the live honey-pots to give up some of their store. Mouth to mouth the feeder and the filled honey-ant would stand or cling for some minutes. And there was no doubt of what was going on. The honey-pot was this time forcing honey out of its own over-filled crop and into the mouth of the nurse.

Thus all the time there went on a constant emptying and replenishing of the strange honey-pots. What an extraordinary kind of life! Nothing to do but to drink and disgorge honey; to cling motionless to the ceiling of a little room, or lie helpless, or feebly dragging about on the floor and be pumped into and pumped out of! To have one's body swollen to several times its natural size by an overloaded stomach, and to be likely to burst from a fall or deep scratch!

But there is simply no telling beforehand what remarkable condition of things you may find in an ant's nest. There is an ardent naturalist student of ants in the great museum of natural history in New York, who keeps publishing short accounts of the new things he is all the time discovering about the habits and life of ants. And if I didn't know him to be not only a perfectly truthful man but a trained and rigorously careful observer and scientific scholar, I should simply put his stories aside as preposterous. But on the contrary, as I do know them to be true, I am more and more coming to be able to believe anything anybody says or guesses about ants! Which is, of course, not a good attitude for a professor!

Dr. Wheeler, this New York student of ants, is putting a great deal of what he knows about ants into a large book which, when published, will make a whole shelfful of green, red, blue, and yellow fairy

books hide their faded colors in shame. For tellers of fairy tales cannot even think of things as extraordinary and strange as the things that ants actually do!

But what a prosaic lecture this story of the animated honey-jars has come to be. Mary is long ago asleep, curled up in a big leather arm-chair in my study, and I sit here in the falling dusk, straining my bespectacled eyes to write what will, I am afraid, only put other little girls to sleep. Which is not at all my idea in writing this book. It is, indeed, just the opposite. It is to make anybody who reads it open his eyes. But, "*Schluss*," as my old Leipzig professor used to say at the end of his long dreary lecture. So *Schluss* it is!

HOVSES · OF · OAK

HOUSES OF OAK

THERE are eight different kinds of oak-trees growing on or near the campus where Mary and I live. And each kind of oak-tree has several kinds of houses peculiar and special to it. Which makes altogether a great many styles and sizes of houses of oak for Mary and me to get acquainted with. For we have made up our minds to know them all, and something about the creatures that live in them. This is a large undertaking, we are finding, but an intensely interesting and delightful one. Some of it is quite scientific, too, which makes us proud and serious. We are keeping notes, as we did about Argiope and the way it handled flies and bees, and some day we shall print

these notes in the proceedings of a learned society, and make a real sensation in the scientific world. Anyway we think we shall. Just now, however, we shall only tell the very simplest things about these houses of oak and their inhabitants, for we suppose you wouldn't be interested in the harder things; perhaps, indeed, not even understand them all.

Although, as I have already said, there are eight different kinds of oak-trees growing in our valley and mountains, two of these kinds, the live-oaks and the white oaks, are by far the most common and numerous. As one stands upon the mountain tops or foothills and looks down and over the broad valley, all still and drowsy under the warm afternoon sun, it seems as if he were looking at a single great orchard with the trees in it in close-set regular lines and plots in some places, and irregularly scattered and farther apart in other places. Where they are regular and close together,

they really are orchard trees; where they are irregular and widely spaced and larger, they are the beautiful live-oaks and white oaks that grow in all the grain-fields and meadows and pastures of our valley. The live-oaks have small leaves, dark green and close together, and the head of the tree is dense and like a great ball; the white oaks have larger, less thickly set leaves of lighter green, and the branches are more irregular and straying and they often send down delicate pendent lines that swing and dance in the wind like long tassels. The live-oaks have leaves on all the year through; the white oaks lose theirs in November.

In both of these kinds of trees the oak houses can be found, but especially in the white oaks. And there are, as I have said, many kinds of the houses. Mary and I have found little round ones, big bean-shaped ones, little star-shaped ones, slender cornucopia-like ones, green, whit-

ish, red-striped, pink-spotted, smooth, hairy, rough-coated, spiny ones, and still other kinds. Some of the houses are on the leaves, some on the leaf-stems, some on the little twigs, and some on the branches. Some of the houses stay in the trees all through the year, but most of them drop off in the autumn, especially in the white-oak trees, just as the leaves do.

We go out and hunt for the houses in the trees and among the fallen leaves on the ground under the trees. They are sometimes, especially the little ones, hard to find, for their colors and shapes often seem to fit in with their surroundings, so as to make them very hard to see. But others, like the big ball-shaped white ones shown in Sekko Shimada's picture, are, on the contrary, very conspicuous. If the houses are on the ground, or even if they are still on the tree and we think they are all through being made—and there are various ways of knowing about this, but

the most important is the time of year—Mary and I bring them home with us and put them in little bags of fine cloth netting, tarlatan usually, the houses that are alike and from one place being put together in a single bag. Then we tie a string around the mouth of the bag and wait for the dwellers in the houses to come out.

For one has to be careful about trying to see the oak-house dwellers before they are ready to come out. It is much better to await their own sweet pleasure in this matter, than to go digging or prying in, for the houses have no doors or windows until just at the time the dwellers come out! In fact they make the doors as they come out. You will see, after we tell you a little more, that this arrangement is a very good one. Even as it is, various unwelcome intruders find their way into the house much to the annoyance and even to the fatal disaster of the inmates.

So we wait until the dwellers are ready

to come out. Or if occasionally we really think we ought to see how things are going on inside, we chop a house or two open and see what we can see. What this is, usually, is a house's insides very unusual and curious, for the rooms occupy so little space and the walls so much. Sometimes there is only one room and that right in the middle, all the rest of the house being just a dense or sometimes loose and spongy wall all around it. In the single room, or in each of the several rooms, we find a curled-up little shining white grub without legs, and of course without wings, and with a head that doesn't seem much like a head, for it has no eyes nor feelers, and most of the time is drawn back into the body of the grub so that it is hardly visible at all. But there is a mouth on this silly sort of head, and the grub eats. What it eats is part of its own house!

The houses, or galls, as the entomologists call them, are of course not actually made

by the insects that live in them; they are made by the oak-tree on which they are. But they are only made at the demand, so to speak, of the insects. That is, the oak-galls are formed only where a gall-insect has pricked a live leaf or stem or twig with her sharp, sting-like little egg-layer, and has left an egg in the plant-tissue. Nor does the gall begin to form even yet. It begins only after the young gall-insect is hatched from the egg, or at least begins to develop inside the egg. Then the gall grows rapidly. The tree sends an extra supply of sap to this spot, and the plant-cells multiply, and the house begins to form around the little white grub. Now this house or gall not only encloses and protects the insect, but it provides it with food in the form of plant-sap and a special mass or layer of soft nutritious plant-tissue lying right around the grub. So the gall-insect not only lives in the house, but eats it!

After it is full-grown, the grub stops eating. Then the house, or gall, stops growing and becomes harder and changes from greenish to some other color, and, in most cases, pretty soon drops off the tree to the ground. The gall-insect is still alive inside, of course, but is perfectly quiet and is simply waiting. It is at this time in the life of the houses and their dwellers that Mary and I collect them and bring them home and put them into little tarlatan bags. This is autumn, the time that the trees in the East turn yellow and red, but in California do not. They just stay green, but get quiet or turn brown or simply drop off their leaves and stand bare.

All through the autumn and winter the gall-insects do nothing inside their houses. Indeed we can take them out and keep them in little vials, and most of them get on very well. They require no food; they simply want to be let alone. But in early spring—and spring in California comes

very early; indeed, it comes in winter!—they wake up and in a short time change into stout-bodied little real insect-looking insects with six legs, four wings, a round head with feelers and eyes and whatever else an insect's head ought to have. Especially sharp jaws. For each gall-dweller has now to get out of its house. And as there are no doors, it has to make them. Which it does with its sharp jaws, gnawing a tunnel from the center of the house right out through the thick hard wall to the outside.

When it gets out it flies around in lively manner for a few days, finally settling on a sprouting oak-leaf or bud or green stem or twig, and laying a few eggs, or several, or many, according to the habits of its special kind, and then it dies. And when the tiny white grubs hatch from these eggs, new houses begin to be made around them by the oak-trees, and a new generation of gall-insects is fairly started.

But not all the dwellers in the houses of oak have such a smooth and easy life as I have described. There will often come out of one of the galls that Mary and I have in a tarlatan bag, not one kind of insect, but several kinds, and only one of these kinds is the regular proper house-owner. The others are interlopers. Some of them may be only uninvited but not especially harmful guests, just other kinds of gall-insects that seem to have given up the habit—if they ever had it—of starting houses of their own, and have adopted the cuckoo-like way of laying their eggs in the just-starting houses of other gall-insects. The grubs, or young of these messmate gall-insects, live in, and feed on, the same house, with the rightful dwellers, but as the oak-tree has plenty of sap and the gall-house is usually large enough for all, there is generally no harm done by these cuckoo intruders.

But some of the intruding insects that

come from our galls are not so harmless. They are the ones called parasites. They live in the houses not for the sake of the protection or the food furnished by the house, but in order to eat the actual dwellers in the house. Often and often not a single real gall-insect would come out in the spring from many of our collected houses, but only a little swarm, or sometimes just two or three or even one, of these insect-devouring parasites that has eaten up the rightful owners of the houses.

There are other enemies, too, of the oak-house dwellers. Birds like to peck into the soft, growing galls to get at the tidbits inside. And predaceous beetles and other strong-jawed insects with a fondness for helpless, soft-bodied, juicy grubs would like to gnaw into the houses. So the houses have to protect the dwellers inside, and they do this in various ways. Some are extra thick-walled or have an extra-

hard outer shell. Some are covered with spines or hairs. Some have a viscous gluey excretion; some have a very bad odor; some are so colored and patterned that they are very hard to distinguish from the foliage or from the fallen leaves around them; and, finally, some secrete a sweetish honey-dew which attracts ants, and these fierce visitors, who are content with the honey-dew, probably drive away many visiting parasites and predaceous insects.

But it would be tiresome to go on and tell you all the things we are finding out about the houses of oak and the insects that live in them. Of how we have got them to lay their eggs right before our eyes on little fresh branches that we bring into the house. Of how the houses begin to form under the bark or leaf surface as mere little swellings and then break through and get larger and larger and take on their characteristic form and color. Of how we have to study the gall-dwellers with a mi-

croscope, for the largest that we have found yet—the ones that make the big galls shown in Sekko's picture—are only one-fifth of an inch long, while others are not more than one-twenty-fifth of an inch long. Of how some kinds have to lay their eggs always on the same kind of oak-tree, while others prick different kinds of oaks.

Nor can we tell of the questions and problems that we are trying to answer. As why it is that two galls made by two different kinds of gall-insects, but in the same parts, as leaves, of the same oak-tree, should be so different, or why the galls in different kinds of trees, though made by the same kind of insect, should be alike, as they usually are. And why with some kinds of the house-dwellers the children grow up to be different from the mother, but their own children grow up like the grandmother, and different from themselves. Or how they know not to lay too many eggs in one place, the ones mak-

ing little galls often laying several to many eggs in one leaf, but the ones making large galls being careful to lay only one egg in a leaf. And a lot of other things that they do that need explaining.

Perhaps we shall find out the reason for some of these things. But naturalists have known the houses of oak-insects for two hundred years now, and if they haven't found the answers to some of these questions yet, perhaps no one ever can. But that isn't a good way to look at Nature. And so Mary and I don't. We think we may make a great discovery any day. We are like prospectors in the gold mountains. We never give up; we always keep prying and peering. The worst of it is, I suppose you think, that we always keep talking too. Well, this is the last sentence of this dose of talking; or next to last. For this is the

END

of this rambling, talky, little book.